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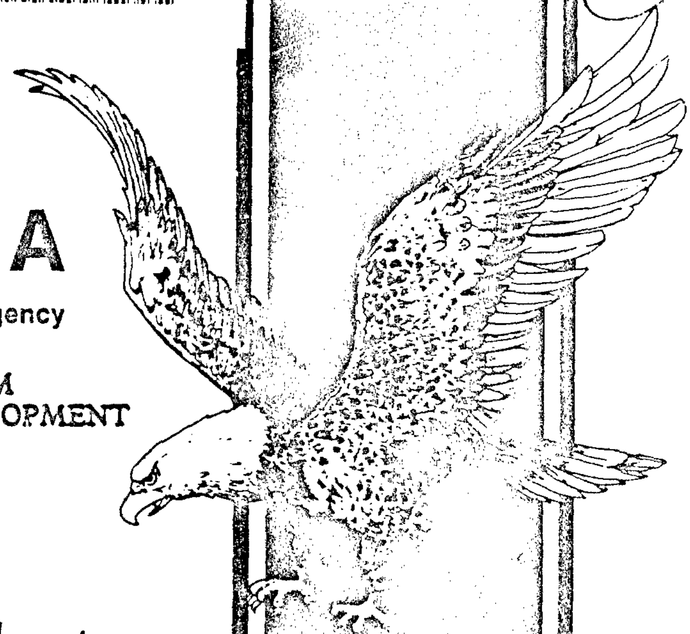

USATHAMA

U.S. Army Toxic and Hazardous Materials Agency

INSTALLATION RESTORATION PROGRAM
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT

Task Order - 12 Field Demonstration - Composting of Propellants Contaminated Sediments at the Badger Army Ammunition Plant (BAAP)

Contract Number DAAK-11-85-D-007
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March 1989

Prepared for:
COMMANDER, U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
Aberdeen Proving Ground (Edgewood Area),
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FIELD DEMONSTRATION - COMPOSTING OF PROPELLANTS - CONTAMINATED SEDIMENTS AT THE BADGER ARMY AMMUNITION PLANT (BAAP)

DRAFT FINAL REPORT

DISTRIBUTION UNLIMITED

Prepared for:

U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground
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March 1989

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A field-scale demonstration of composting propellants-contaminated sediment was conducted at the Badger Army Ammunition Plant (BAAP). Composting, as used at BAAP, is a treatment process in which organic-chemical contaminated soils or sediments are mixed with organic materials such as manure to enhance the role of microbial metabolism in degrading and stabilizing soil/sediment contaminants. Sediments contaminated with the propellant nitrocellulose (NC) were mixed with manure, alfalfa, livestock feed, and wood chips and composted in four static piles. Negative pressure aeration was used to maintain aerobiosis and remove excess heat. Experimental variables investigated during the study were temperature (mesophilic, 35°C vs. thermophilic, 55°C), sediment loading (19 to 32 weight percent), and NC loading. Small aliquots of compost (approximately 400 cm^3) were spiked with pure NC, placed in porous nylon bags and buried in compost piles nos. 1, 2, and 3. These bagged compost samples were used to determine if high levels of NC (up to 80 weight percent) could be successfully composted. Thermophilic temperatures resulted in the highest percent reduction in NC concentration. Compost pile no. 1 contained 19 weight percent sediment, was maintained at approximately 35°C, and resulted

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in 28 percent NC destruction. Compost pile no. 2 contained 19 weight percent sediment, was maintained at approximately 55°C, and resulted in 98 percent NC destruction. Compost pile no. 3 contained 22 weight percent sediment, was maintained at approximately 55°C, and resulted in 99.6 percent NC destruction. Compost pile no. 4 contained 32 weight percent sediment, was maintained at approximately 55°C, and resulted in 99.9 percent NC destruction. Significant reduction in NC concentration occurred in all bagged compost samples except for the bags that contained 80 weight percent NC in compost pile no. 3.

ACKNOWLEDGEMENTS

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SECTION 1

EXECUTIVE SUMMARY

A field-scale demonstration of static pile composting to decontaminate nitrocellulose-contaminated soils was conducted at the Badger Army Ammunition Plant (BAAP). In addition, the potential applicability of composting for destruction of NC production waste (NC fines) was investigated. Composting at BAAP is a biological treatment process in which contaminated soil or sediment is mixed with bulking agents/carbon sources (organic materials such as alfalfa and manure) to enhance microbial metabolism and destruction of soil contaminants.

The primary objective of this study was to evaluate the utility of aerated static pile composting as a technology for NC fine remediation and destruction of NC-contaminated soil. Secondary objectives of this study included an evaluation of the efficacy of thermophilic (55°C) versus mesophilic (35°C) composting, determination of a maximum soil loading rate, and a comparison of different process control and material handling strategies. These objectives were met by conducting the field demonstration described in this report.

Two compost piles were established during each of two consecutive test periods. Temperature was the primary test variable investigated during Phase I of the project. Of the two piles studied during this phase, one (pile 1) was maintained at approximately the mesophilic temperature optimum (35°C) and one at approximately the thermophilic temperature optimum (55°C). Compost piles are self-heated when energy released from microbial metabolism of organic matter is trapped within the compost matrix. Therefore, no external heat sources were required. Vacuum (drawn) aeration was used to remove excess heat and to maintain aerobic conditions within the compost piles.

The ability to compost at different soil loading rates was the primary variable distinguishing the two piles established during Phase II. Soil loading was increased from 19 percent (by weight) in the Phase I piles to 22 percent in pile 3 and 32.5 percent in pile 4. Temperature within both piles was maintained in the thermophilic range based upon the degradation achieved in Phase I. Bags of compost containing NC concentrations as high as 80 percent (by weight) were placed within pile 3 to investigate degradation of NC at high concentrations. The mixture to be composted in all four piles was prepared by mixing soil contaminated with NC fines with alfalfa, feed, wood chips and/or mulch, and cow manure. The piles in Phase I actively composted for 151 days. The initial concentrations of NC were 908 mg/kg for pile 1 and 3,039 mg/kg for pile 2 at time-zero. At the end of the study period, the concentrations

·f NC were reduced to 651 mg/kg and 54 mg/kg for piles 1 and 2, ·espectively. Mean percent reductions of NC in piles 1 and 2 ·ere 28 percent and 98 percent, respectively.

:he two piles (3 and 4) established for Phase II of the BAAP ›roject actively composted for 112 days. The initial NC con- :entrations were 7,907 mg/kg in pile 3 and 13,086 mg/kg in pile 4. The final concentrations of NC were 30 mg/kg in pile 3 and 16 mg/kg in pile 4. These data represent mean percent reduc- :ions in NC concentration of 99.6 percent and 99.9 percent, re- spectively. Significant reductions were also observed in con- taminant levels in the NC-spiked bags, with only the 80-percent NC concentration exhibiting little degradation.

These data indicate that composting is a feasible remediation technology for decontaminating NC-contaminated soils and sedi- ments. In addition, composting at high loading rates appears to be a viable option for destruction of NC fines.

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SECTION 2

INTRODUCTION

2.1 STATEMENT OF THE PROBLEM

The manufacture and handling of explosives and propellants has resulted in soil and sediment contamination at U.S. Army munitions facilities as a result of previously acceptable waste disposal practices. One such contaminant is nitrocellulose, a propellant commonly used in munitions and rocket motors. Out-of-specification NC (NC fines) are produced during NC manufacture and present problems for disposal. The fines also are of concern because of the risk of environmental contamination.

The United States Army Toxic and Hazardous Materials Agency (USATHAMA) is currently investigating several technologies for remediating NC-contaminated matrices and disposing of NC fines. Among the candidate technologies is composting. USATHAMA has previously conducted laboratory- and pilot-scale tests of this technology (Doyle et al., 1986). Results of these studies were encouraging and warranted a field-scale demonstration. This report describes the results of a composting field demonstration for NC destruction that was conducted at the Badger Army Ammunition Plant (BAAP). WESTON initiated this field demonstration in April 1988.

2.2 BACKGROUND INFORMATION

Composting is a process in which organic materials are biodegraded by microorganisms, resulting in the production of organic and inorganic byproducts and energy in the form of heat. This heat is trapped within the compost matrix, leading to the self-heating phenomenon characteristic of composting. Composting is initiated by mixing biodegradable organic matter (NC in the present study) with organic carbon sources and bulking agents, which are added to enhance the porosity of the mixture to be composted. Bulking agents may also provide additional organic carbon to the microorganisms. In this report, the term "bulking agents" is used to refer to materials that provide both porosity and degradable organic matter.

The environment in a compost matrix is substantially different from the environment within aerobic soils in that the matrix to be composted has a much higher concentration of organic matter. This organic-rich environment leads to intense microbial metabolic activity and the production of heat. The production of metabolic heat and the insulative properties of the compost matrix create a self-heating environment that serves to further stimulate microbial activity. If left unchecked, temperatures may readily exceed 70°C, a temperature that inhibits most microorganisms and leads to a decline in metabolic activity.

Composting is applicable to the remediation of soils contaminated with any biodegradable compound(s). Materials and facilities required include a biodegradable organic substrate, bulking agents to increase the porosity and organic carbon concentration of the mixture to be composted, water, a containment structure to prevent contaminant migration, mixing equipment, and a means to provide oxygen to the composting materials. Parameters that affect the efficiency of the composting process include temperature, moisture content, and chemical and biological characteristics, as well as the concentration of the organic substrate, the concentration of inorganic nutrients such as nitrogen and phosphorus, heat retention characteristics of the compost, and the partial pressure of oxygen within the composting material.

Microorganisms that catalyze the composting process and degrade organic constituents are generally present in the materials used to prepare a compost mixture. No supplemental organisms are typically required. Special circumstances may exist where supplementary microorganisms may be useful, but this was not the case in the present study.

Composting may be implemented at one of three general levels of technology. These levels differ in the degree of manipulation and process control attained. Consequently, costs increase at higher technological levels. At the lowest level, the material to be composted is simply shaped into the form of a pile and allowed to self-heat. Water and/or nutrients may be added. However, air exchange is poor and temperatures may fluctuate widely within the composting material. Periodically turning the material increases aeration but process control remains negligible. This level of technology is often referred to as a "windrow" system, so named because of the long rows of narrow compost piles typically employed.

At the next technology level, an aeration/heat removal system is utilized to increase process control over the composting system. The aeration/heat removal system typically takes the form of a network of perforated pipe underlying the compost pile. The pipe is attached to a mechanical blower and air is periodically drawn or forced through the compost to effect aeration and heat removal. This level of technology is often referred to as a "static pile."

At the highest technology level, a system of enclosed composting vessels and automated materials handling equipment is used (in addition to an aeration/heat removal system) to produce a continuous treatment process. This type of system is often referred to as "in-vessel" composting.

Composting is widely used to stabilize wastewater sludges and municipal refuse in the United States and Europe (Biocycle Special Report, 1987). The primary objectives of refuse/sludge composting are to:

- Reduce the volume of waste or sludge.
- Reduce the moisture content of the composting material.
- Destroy potentially odorous nitrogen and sulfur containing organic compounds.
- Destroy pathogenic microorganisms.
- Stabilize the compost material for ultimate disposal.

Since sludge and refuse are generated continuously, these objectives are best met by a composting system designed for relatively rapid turnover of incoming wastes. The rate of waste disposal must approximate the rate of waste loading for wastewater and refuse facilities to operate efficiently. In contrast, the primary objective of hazardous materials composting is to convert hazardous substances into innocuous products for ultimate disposal. Rapid processing is desirable, but remains secondary to successful treatment of the waste. Thus, while hazardous materials composting systems share many of the characteristics of sludge and refuse composting systems, operational parameters will differ according to the primary objective of the process.

Composting is a combination of biological and engineering processes. Biological aspects of the process that require management include optimizing environmental conditions to enhance microbial growth and maximizing contaminant destruction within the compost pile. Engineering aspects requiring attention include materials handling, composting facility design and operation, and process control systems. Both biological and engineering requirements must be addressed to provide a cost-effective and successful treatment process.

A number of studies have demonstrated the aerobic biotransformation of explosives and propellants. Successful composting of explosive- and propellant-contaminated soils has been achieved at both laboratory- and pilot-scales. These studies have indicated that composting is a feasible technology for the treatment of soils contaminated with propellants and explosives. To assess composting of propellant-contaminated soils, WESTON conducted a field-scale demonstration on-site at BAAP. This report details the findings of that project and includes recommendations for future work and full-scale implementation.

2.3 LITERATURE SUMMARY

Nitrocellulose (NC) is a highly substituted cellulose that is used as a propellant for munitions and rocket motors. Synthesized from cotton or wood pulp, NC may contain from 11.11-percent nitrogen (cellulose dinitrate) to 14.5-percent nitrogen (cellulose trinitrate) (Riley et al., 1984).

While not considered toxic, the EPA water quality criteria for turbidity and solids deemed protection of the aquatic environment from NC contamination a necessity. The fibrous nature of the compound can pose a hazard to benthic communities by eliminating interstitial habitats and reducing oxygen levels by "blanketing" the sediment. These concerns are further compounded by NC's relative resistance to biodegradation under ambient environmental conditions (Ryan, 1986).

In studies examining the biodegradation of NC, Brodman and Devine (1981) reported a significant release of extractable nitrate from the test matrix, which they believe was attributable to microbial hydrolysis of NC. After adjusting the data for controls, a 0.203-percent release of nitrate from a 1-percent nitrocellulose concentration was reported. However, Riley et al., (1984) reported a 0.005-percent release of nitrate from a five-fold greater quantity of NC. After analyzing for nitrate, nitrite, ammonia, and nitrogen-gas production, which would have been indicative of NC degradation, they concluded that NC was not susceptible to microbial attack.

Atlantic Research Corporation examined the susceptibility of NC to microbial degradation in a composting system. Using ^{14}C labeled NC in BAAP site soil, they demonstrated a rapid degradation of NC with substantial evolution of $^{14}CO_2$. Overall average recovery of ^{14}C was 106.2 percent with a standard deviation of 12.4 percent (Doyle et al., 1986).

2.4 SITE BACKGROUND

BAAP is located on a 7,354-acre site in Sauk County, Wisconsin (see Figure 2-1). Constructed in 1942, the plant operated intermittently over a 33-year period, producing single- and double-base propellants for rocket, cannon, and small arms ammunition. BAAP's production facilities and support facilities were placed on standby status in March 1975.

During the plant's period of active operation, various chemical materials were produced, and the associated wastes and manufacturing byproducts disposed of through practices both common and acceptable at the time. The wastes included acids, nitroglycerin, and NC. As a result of the disposal practices, contamination of soils, the underlying aquifer, and, to some extent, surface waters have occurred.

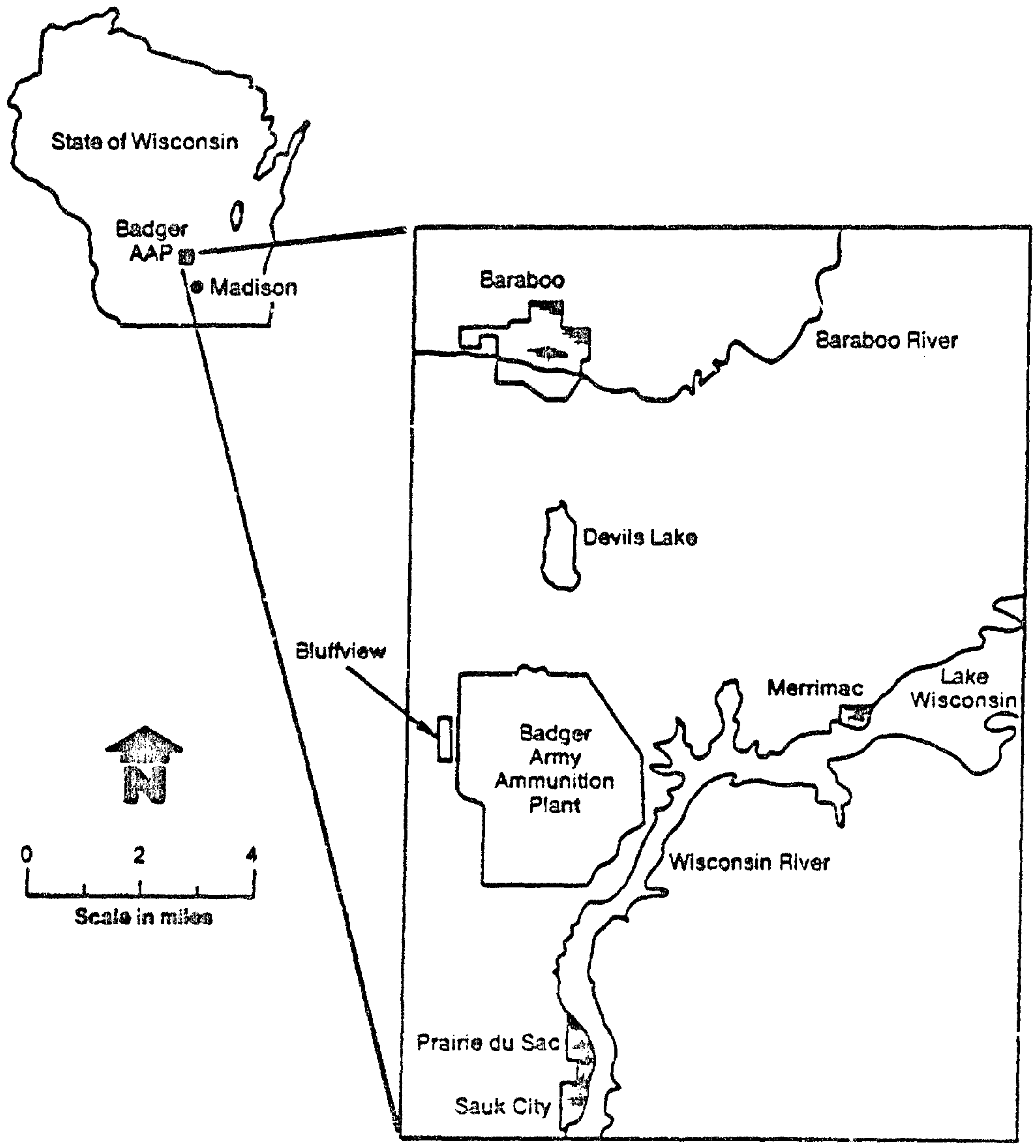


Figure 2-1. Location of BAAP in Wisconsin.

2.5 OBJECTIVES

The primary objective of this study was to evaluate the utility of aerated static pile composting as a technology for NC fine remediation and destruction of soils contaminated with NC. Secondary objectives of this study included an evaluation of the efficacy of thermophilic (55°C) versus mesophilic (35°C) composting, determination of a maximum soil loading rate, and a comparison of different process control and material handling strategies. Aspects that were not part of this investigation included:

- Toxicological evaluation of the initial soil, NC, or the final compost residue.
- Minimization of carbon supplements and bulking agent utilization.
- Determination of transformation products.
- Determination of an engineering design and management plan for full-scale implementation.
- Process cost analysis.

SECTION 3

MATERIALS AND METHODS

This section contains information on materials and methods that pertain to all four compost piles studied at BAAP. Information specific to compost piles 1 and 2 or 3 and 4 is presented in Sections 4 and 5, respectively.

3.1 COMPOSTING TEST FACILITIES

The composting test facilities were located on a graded area adjacent to the BAAP wastewater treatment plant (see Figure 3-1). Two 6-inch-thick concrete test pads (28 feet x 38 feet) were constructed over a 6-inch layer of sand and mesh. Each pad contained a 4-inch concrete berm along three sides of the perimeter to contain any runoff. The pads drained via a 4-inch PVC pipe to a 6 feet x 8 feet x 6 feet sump. Liquids contained in the sump were reapplied to the compost during remixing. However, if the volume contained within the sump became excessive, the contents were tested and discharged under the requirements of the NPDES-permitted treatment system. The pads were covered by a wooden beam-supported, corrugated tin roof (14 feet eave height). This structure protected the piles from weather and minimized the amount of moisture collected in the sump due to precipitation.

A mixing pad was also constructed to provide a solid, nonpermeable surface for materials handling. The mixing pad was composed of a concrete slab with 6-inch steel mesh and grade beams along the edges. Rebar was added to provide increased resistance to cracking along the edges.

BAAP provided 110-V and 220-V power and a water supply.

3.2 BULKING AGENTS/CARBON SOURCES

A cow manure slurry was obtained from the U.S. Dairy Forage Research Center. Primarily a liquid, the manure provided carbon, microbes, nutrients, and moisture to the compost matrix.

Alfalfa, straw, and horse feed were obtained from local distributors. In Phase I (piles 1 and 2) of the BAAP project, one half of the purchased alfalfa was fed through a mixer to break up the larger grasses and produce a more homogeneous mixture. In Phase II (piles 3 and 4), only unchopped alfalfa was added to the compost mixture in an attempt to increase the porosity of the pile. Baled straw was used to contain the pile contents, and was arranged in a ring around the perimeter of each pile (see Figure 3-2). Sawdust and hardwood and softwood mulch were obtained from local suppliers and used to construct

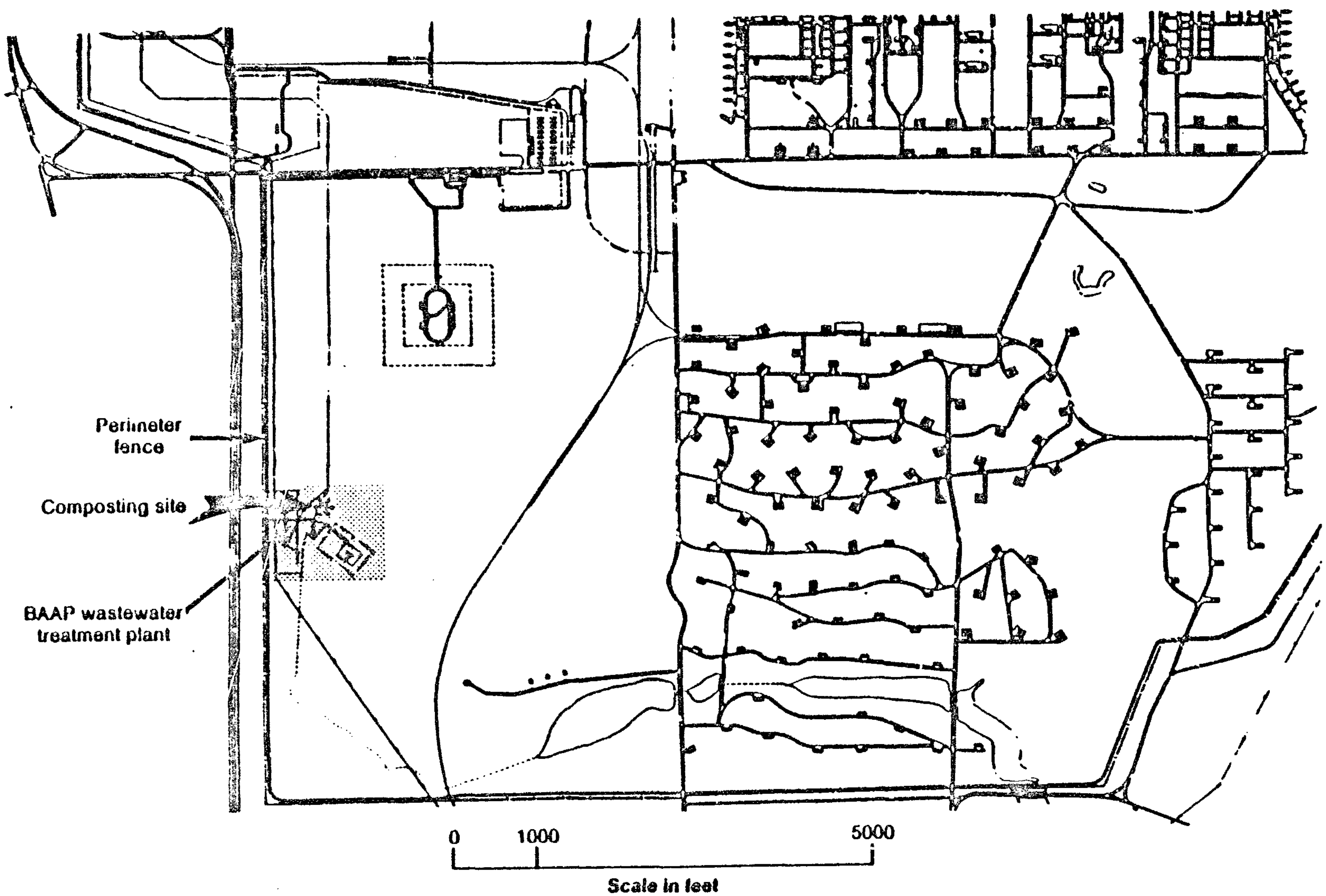
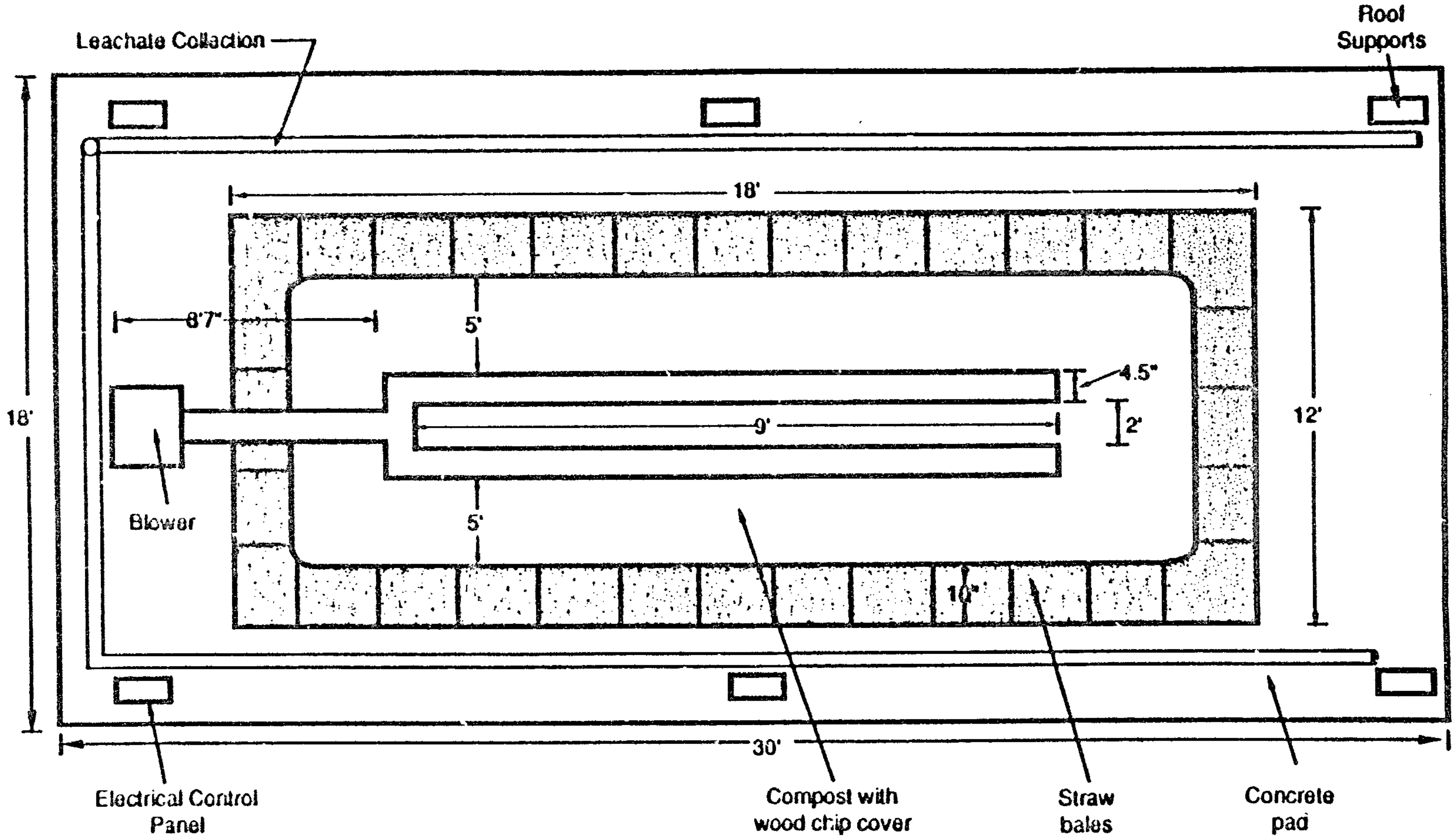


Figure 3-1. Location of composting test pads, Badger Army Ammunition Plant.



Note: Schematic only, not to scale.

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Figure 3-2. Overview schematic diagram of Compost Pile, Badger Army Ammunition Plant.

the pile bases, provide additional bulking material, and to insulate the piles (see Figure 3-3).

3.3 MIXING SYSTEM

A Knight 2000 Series Reel Auggie mixer from Knight Manufacturing Corporation in Broadhead, Wisconsin (see Appendix B), was used for preparing and remixing the compost mixture. The mixer was powered by an external drive-shaft connected to a tractor, which rotated large stainless steel augers within the mixing bin. After mixing, the compost was emptied through a hydraulic ramp into a front-end loader bucket and transported to the composting pads. The mass of the material in the mixing bin was monitored using an installed computerized scale.

3.4 TEST SOIL

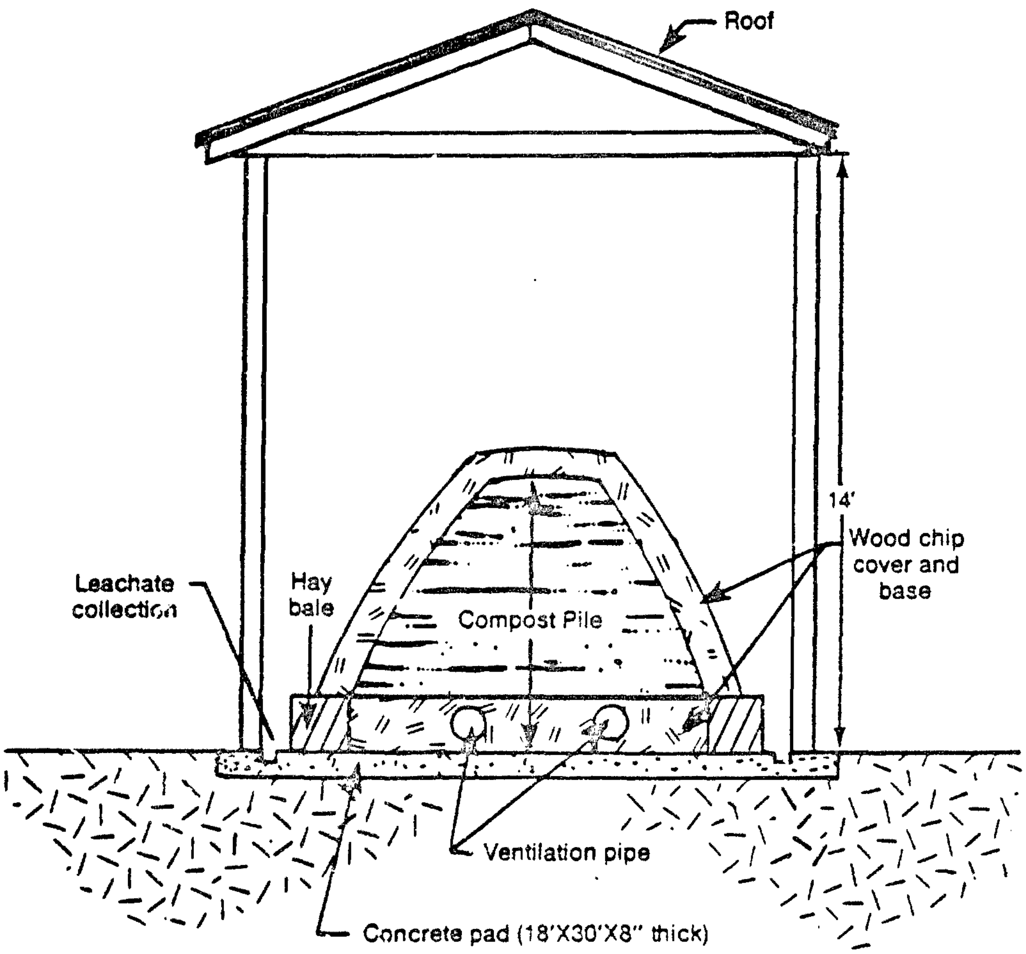
Test soils were excavated from Dredge Spoil Basin No. 1 at BAAP (see Figure 3-4). A front-end loader was used to remove the overlying sod and excavate the underlying soil. The soil was loaded into a dump truck and transported to the mixing pad, where it was homogenized and sampled for analysis of the initial NC concentration. The soil was covered with a plastic tarp until the day of use.

Excavation of test soil for piles 1 and 2 was performed on 12 April 1988. Approximately 6 cubic yards of soil were removed from the center of the basin. The test material was dark brown, moist, and richly organic in appearance. On 26 September 1988, approximately 7 cubic yards of soil were excavated for use in the construction of piles 3 and 4. The soil was removed from an area adjacent to the excavation site for piles 1 and 2. All compost, soil, and bulking agents from Phase I were disposed of in Dredge Spoil Basin No. 1 in an area removed from the site of soil excavation.

The NC concentrations in the test soils for Phase I and Phase II of the BAAP project are presented in Table 3-1.

3.5 MATERIALS HANDLING EQUIPMENT

A front-end loader, equipped with a 1-cubic yard bucket, and a dump truck were used to transport soil from the dredge spoil basin to the test site. A Knight 2000 Series Reel Auggie mixer was used to homogenize the soil and the mixture to be composted. A farm tractor was used to power the drive shaft that turned the augers within the mixer. Horse feed was stored in grain bins until used. Smaller-scale materials handling activities were performed with hand tools such as rakes, shovels, and pitchforks.



Note: Schematic only, not to scale.

Figure 3-3. Cross-sectional schematic of compost pile with roof, Badger Army Ammunition Plant.

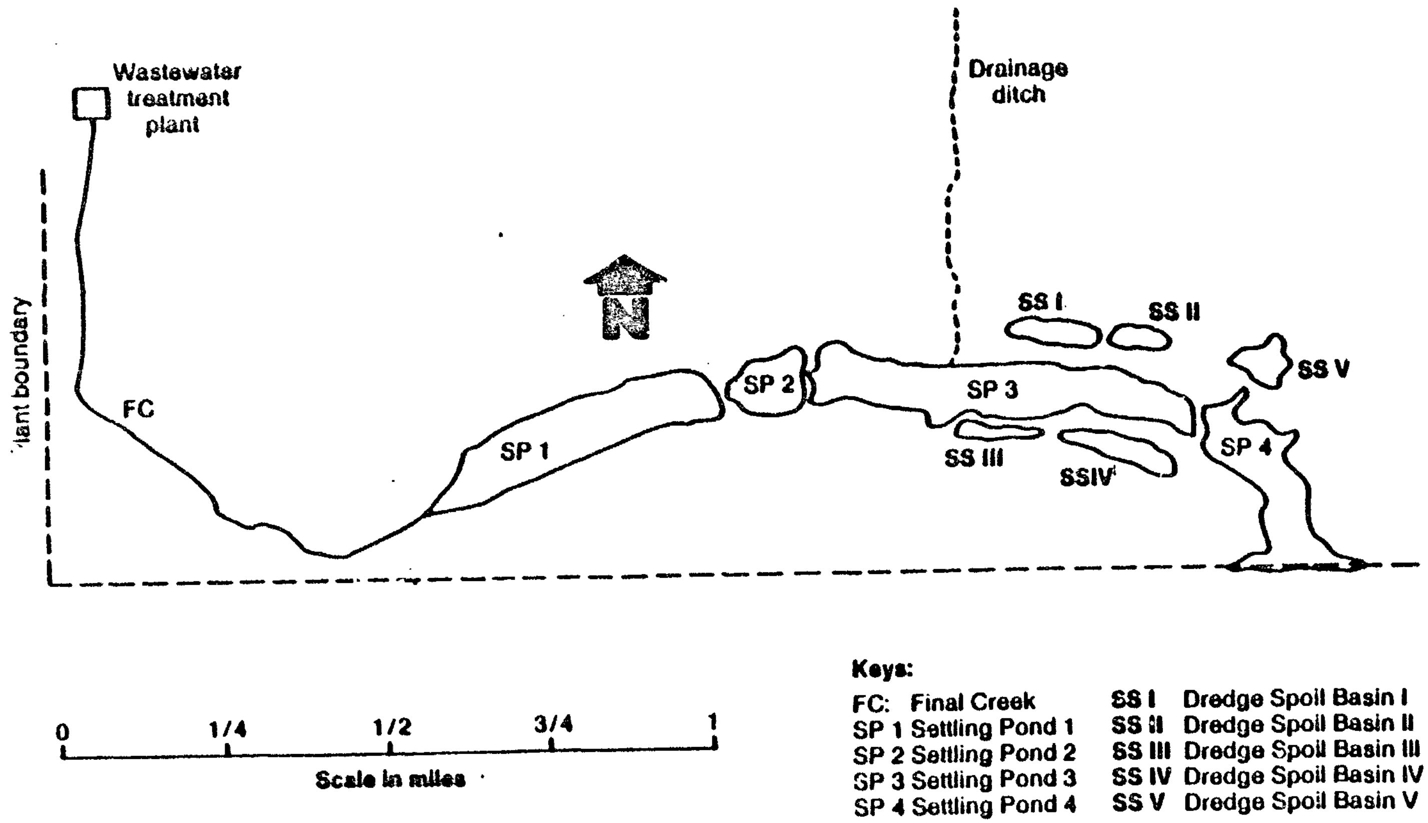


Figure 3-4. Location and relationship of Dredge Spoil Basins and Settling Ponds Badger Army Ammunition Plant.

Table 3-1

Concentrations of NC in Test Soils, Collected from Dredge Spoil Basin No. 1, BAAP (concentrations in mg/kg)

Date Collected	NC Concentration
4/12/88	18,800 ± 1,347
9/26/88	17,027 ± 4,358

± = 1 standard deviation.

3.6 COMPOST TEMPERATURE/AERATION CONTROL

Each compost pile contained a system of perforated and nonperforated polyethylene pipe (4 inches in diameter) that was placed on top of the wood chip bases and connected to an explosion-proof Peerless PW-12 radial blade blower (single-phase, 2-hp, 860-scfm, 6-inch static pressure). The blowers were used to pull air through the compost piles to promote aeration and remove excess heat (see Figure 3-2).

Blower cycling was controlled by both timer and temperature feedback systems. The feedback system consisted of soil thermistors that measured compost temperature and panel-mounted Fenwal Series 551 thermistor sensing temperature controllers. Timer control was obtained by programmable timer relays mounted in the thermistor control panels.

The thermistor controllers had low- and high-temperature set-point values that were operator-set. The low and high set-points on the thermistor controller in the mesophilic compost pile (pile 1) were 31°C and 35°C, respectively. The corresponding values for the thermophilic piles (2, 3, and 4) were 51°C and 55°C. After pile construction, the blowers were placed on timer control (40 seconds on per 20-minute cycle) to provide oxygen to the piles while minimizing heat removal during the startup phase. After the piles reached operating temperature (2 to 3 days), blower control was automatically transferred to the temperature feedback system.

The temperature feedback system provided three functions. When the pile temperature, as registered by the thermistor, was: below the low set-point, the blower operated on timer control; between the low and high set-points, the blower did not operate; above the high set-point, the blower operated continuously until the compost temperature (as monitored by the thermistors) fell below the high set-point.

When the compost temperature was below the low set-point, the blower operated intermittently (timed on/off cycling) to aerate the pile with minimal cooling. When the compost temperature was between the low and high set-points, the blowers did not operate in order to allow the compost pile to reach the high set-point. When the compost temperature exceeded the high set-point, the blowers ran continuously to lower the compost temperature to just below the high set-point. When the blowers were on, compost temperatures were lowered by both evaporation and the passage of cool ambient air through the pile. In this way, compost temperatures could theoretically be controlled near the optimum levels. The temperature ranges sought during this study were 35 ±4°C and 55 ±4°C for piles 1 and 2 (respectively), and 55 ±4°C for piles 3 and 4.

3.7 COMPOST TEMPERATURE MONITORING

The temperature monitoring system consisted of five landfill probes in each pile that constantly monitored the temperatures in discrete regions of the pile over time. The probes were placed in identical regions within both piles to monitor the variation in temperature at different vertical and longitudinal sectors.

The toe and heel of each pile was monitored at mid-depth, and the central region was monitored at the base, mid-depth, and top. All 10 probes (5 per pile) relayed temperature data to an Omega 10-channel temperature recorder/logger that was housed in the site trailer. The recorder program allowed monitoring of the pile temperatures at discrete intervals over time. Temperature data were printed for each of the 10 probes every 4 hours.

During Phase I of the BAAP project, the 10 temperature probes were placed as follows. Probes 1 through 5 were placed in pile 1. Probe 1 was placed at mid-depth, one-third of the way back from the toe of the pile. Probe 2 was placed at mid-depth in the pile, immediately adjacent to the toe (blower end) of the pile. Probe 3 was placed at mid-depth, in the heel of the pile. Probe 4 was placed 1 foot under the surface of the center of the pile. Probe 5 was placed at the bottom of the pile, two-thirds of the way back from the toe, and immediately adjacent to the side of the pile.

The locations of probes one through five in pile 1 corresponded directly to the locations of probes six through ten in pile 2. The same probe locations were used in Phase II (piles 3 and 4).

Additional temperature data were collected during visits using a hand-held temperature probe with a digital temperature meter. Nine data points were obtained for each pile: longitudinally in the toe, mid, and heel; and vertically at the base, mid-depth, and top. The probe was calibrated against the thermistors at the initiation of the project. On 15 November 1988 (day 49), the electronics in the temperature recorder/logger were rendered inoperable during a lightning storm. Temperature data were collected every two to three days from that time until the final samples were taken from piles 3 and 4 (6 January 1989). The hand-held temperature probe with the digital meter was used to obtain these data.

3.8 MICROBIAL ENUMERATION

The population density of heterotrophic microorganisms was determined for compost samples from all four piles. One gram of compost was asceptically transferred into 90 ml of sterile 0.1 M K_2HPO_4 buffer and agitated by hand for 2 minutes. Large particles were allowed to settle after agitation. The compost extract was serially diluted into sterile phosphate buffer (1 ml extract into 9 ml buffer) to a dilution of 10^{-9}. Each dilution was either spread-plated or pour-plated onto nutrient agar plates (Difco Laboratories). Duplicate plates of compost extracts from piles 1 and 2 were prepared, and one plate from each duplicate set was incubated at 35°C and 55°C for 5 days. Total colony counts were made after days 2 and 5 of incubation. Extracts of piles 3 and 4 compost were plated in duplicate, with both plates in the set incubated at 55°C to encourage growth of the thermophilic population. The total number of microbial (bacterial and fungal) colonies on each plate was used to calculate the number of colony-forming units (cfu) per gram of dry compost.

3.9 ANALYTICAL METHODS

3.9.1 TOC, TKN, and Lead

Analyses for total Kjehldal nitrogen (TKN) and lead were conducted according to procedures outlined in Standard Methods for Chemical Analysis of Water and Wastes (U.S. EPA 600/4-79-020, 1979). TOC analysis was by the Loss-On-Ignition method (Stromm, 1976).

3.9.2 Propellants

Compost samples were analyzed for nitrocellulose according to USATHAMA Method LY02 (see Appendix A), modified for the extraction and analysis of compost.

Steps used in sample preparation and analysis were as follows.

3.9.2.1 Sample Extraction and Preparation

General Method: A solid sample was extracted with acetone using ultrasonic agitation. A portion of the extract was dried and washed with a methanol/water solution to remove endogenous nitrate and nitrite salts. The washed sample was then dissolved in acetone and hydrolyzed by treatment with aqueous potassium hydroxide at an elevated temperature, causing nitrite ion to be cleaved from the nitrite ester. Procaine was diazotized in an acid solution, which in turn reacted with N,N-dimethyl-1-napthylamine to produce a dye with maximum absorbance at 510 nm.

3.9.2.2 Spectrophotometric Analysis

A Perkin-Elmer Lambda 3 Dual Beam UV/VIS spectrophotometer was used to analyze the BAAP compost samples for NC. Calibration checks were performed prior to and following each individual sample.

3.9.2.3 QA/QC Samples

The following QA/QC samples were analyzed with each batch of compost samples:

- Method blank.
- 2x standard spike.
- 10x standard spike.
- 10x standard spike duplicate.

Samples were prepared as described in Subsection 3.9.2.1, with the exception that USATHAMA-standard soil was used as the sample matrix.

3.9.3 Percent Moisture Determination

Triplicate samples of compost material were weighed in a tared aluminum tray and dried overnight at 105°C. Compost samples used for percent moisture determinations were subsamples of compost analyzed for nitrocellulose. The samples were reweighed the following day and the percent moisture calculated as follows:

Percentage Moisture = (water loss/original weight) x 100.

3.10 TEST PERIOD AND SAMPLING

Four compost piles were constructed at BAAP during the period from April 1988 to January 1989. The first set of compost piles (piles 1 and 2) was set up on 28 April 1988 and was terminated on 26 September 1988 (151-day test period). Phase II of the project (piles 3 and 4) was initiated on 27 September 1988 and terminated on 17 January 1989 (112-day test period).

Samples were taken from the compost with a soil auger (Forestry Suppliers, Inc.). The auger had a 3-inch-diameter stainless steel auger bucket and a 5-foot-long extension handle. Sampling was initiated by scraping the cover materials on the compost pile away to expose the compost below. The auger was inserted approximately 24 to 30 inches into the compost pile and a core sample removed. Samples were taken below the longitudinal axes of the piles, 2 to 3 feet below the apex. A minimum of 5 and as many as 10 core samples were removed from each compost pile and analyzed at each sampling time-point. Samples were packed in amber bottles and shipped by overnight freight using chain-of-custody procedures. Additionally, 40-ml bottles were packed with compost and shipped overnight for percent moisture determinations and microbial enumerations.

The exhaust air from the blower system was sampled three times during Phase I of the project. Activated charcoal was used as a trapping medium.

3.11 COMPOST PILE REMIXING

The compost piles were remixed during both the Phase I and Phase II test periods. Hand tools were used to scrape the wood mulch and sawdust off the piles, thus exposing the compost matrix underneath. A front-end loader transported the compost from each pile individually to the mixer, where a total pile weight was determined and recorded using the computerized scale. Water from the sump was used to add moisture to the compost mass, and was pumped via a pressured hose into the mixer while the augers were in motion.

After the contents of the pile were well homogenized and remoistened, the compost material was returned to the pads using a front-end loader and the piles were rebuilt. Samples were taken of the remixed material.

SECTION 4

COMPOST PILES 1 AND 2

4.1 COMPOST PILE DESIGN, CONSTRUCTION, AND OPERATION

4.1.1 Test Variables

The test variable in compost piles 1 and 2 was temperature. Pile 1 was operated to maintain compost temperatures in the mesophilic range (35 ±4°C). Pile 2 was operated to maintain compost temperatures in the thermophilic range (55 ±4°C).

4.1.2 Test Soil and Bulking Agents

The mixture to be composted in piles 1 and 2 consisted of BAAP soil excavated from Dredge Spoil Basin 1 on 12 April 1988 (see Table 3-1), feed, softwood mulch, whole and chopped alfalfa, and cow manure. Bulk density measurements were obtained for each of the pile components and the final compost mixture. A spring scale with a 50-lb capacity was tared to the weight of a hanging steel bracket, and the mass of three separate buckets of tap water was recorded. The volume of the bucket was calculated from these data using the known density of water. Triplicate samples of the compost materials were weighed and the bulk densities determined (see Table 4-1).

Based on visual inspections of the soil particle size, previous pilot-scale studies (Doyle et al., 1986), and data obtained during WESTON's field demonstration at LAAP, a materials balance for the compost mixture components was developed. The initial NC concentration contained in the soils used in piles 1 and 2 was approximately 18,800 mg/kg, or 1.8 percent. This concentration was reduced by dilution when the bulking agents were mixed with the test soil during preparation of the compost mixture. As the maximum concentration of NC that could be composted without proving inhibitory to the indigenous microbial population had not been identified, small bags of compost containing higher levels of NC were incorporated into the pile. Approximately 400 grams of the compost mixture were spiked with NC fines and well homogenized to yield contaminant levels of approximately 3 percent, 5 percent, 7.5 percent, and 10 percent (by weight). The spiked compost was placed in triplicate sets of small nylon bags and placed at mid-depth in the heel of the piles (the area farthest from the blower).

The materials balance utilized for piles 1 and 2 is presented in Tables 4-2 and 4-3.

Table 4-1

Bulk Densities of Materials
Used in Compost Piles 1 and 2

Material	Mean Bulk Density (lb/yd^3)
Soil	1,468
Manure	1,622
Alfalfa (whole)	16
Alfalfa (chopped)	138
Feed	916
Mulch	170
Compost mixture	916

Table 4-2

Materials Balance of Compost Pile 1

Material	Volume (yd^3)	Mass (lb)	Percent Volume	Percent Mass
Soil	1	2,100	2	19
Feed	2	1,730	3	16
Mulch	4	760	7	7
Manure	3	4,820	5	45
Alfalfa (whole)	46	750	75	7
Alfalfa (chopped)	4	620	7	6
Total	62	10,780	100	100

Note: Volume measurements are approximate; materials were measured by weight.

Table 4-3

Materials Balance of Compost Pile 2

Material	Volume (yd^3)	Mass (lb)	Percent Volume	Percent Mass
Soil	1	1,940	3	19
Feed	2	1,680	4	17
Mulch	5	840	12	8
Manure	3	4,680	7	46
Alfalfa (whole)	27	440	64	4
Alfalfa (chopped)	4	550	9	5
Total	42	10,130	100	100

Note: Volume measurements are approximate; materials were measured by weight.

4.1.3 Compost Mixing/Pile Construction

Piles 1 and 2 were constructed using the following sequence:

- Contaminated soil was collected on 12 April 1988, homogenized and piled on the concrete mixing pad using the front-end loader.
- Pile construction was initiated on 28 April 1988.
- Bulk densities were determined for each of the pile components.
- Wood chip bases (7.5 feet x 13 feet x 8 inches) were constructed, aeration piping laid on top, and an additional 3 inches of wood chips placed over the piping to prevent compost from entering the pipe. Pipe connections were secured with snap connectors and duct tape. Nonperforated pipe was used from the blowers through the "T" junction in the toe of each pile and perforated piping was used from the junction to the capped ends (see Figure 3-1). Straw bales were placed along three sides of the base to prevent the material to be composted from sliding off the base. These bales also reduced air short circuiting, provided insulation, and kept the insulating blanket from sliding.
- Soil, alfalfa (both whole and chopped), feed, softwood mulch, and 30 pounds of P:N:K (13/13/13) fertilizer were mixed in the Knight Reel Auggie until a homogeneous mixture was achieved. The computerized scale was used to record the individual component weights.
- The mixer was pulled to the USDFRC, where liquid cow manure was pumped into the mixer. The slurry was added until visual inspection revealed saturation of the components.
- The mixer was returned to the test site, where a hydraulic ramp on the mixer emptied the contents into the bucket of a front-end loader. The compost was then transported to the appropriate test pad.
- The nylon-bagged spiked compost samples were placed at mid-depth in the heel of each pile, and then covered with the remaining compost mixture. Nylon tags with the bag identification were placed within each bag, and also at the ends of attached nylon strings which were run out of the sides of the piles to facilitate sampling.
- The remainder of the mixture to be composted was placed onto each pile, and straw bales placed along the open side.

- Thermocouple and thermistor probes were placed at predetermined regions of each pile, thus providing synonymous data for each sector within the two piles. The 10-channel temperature recorder/logger was set at time zero and programmed to print out data every 4 hours.

- Each pile was covered with 5 cubic yards of sawdust plus 1 cubic yard of softwood mulch to provide insulation.

- The thermistor-activated temperature controller was set to timer operation (40 seconds per 20-minute cycle).

- Samples of the time-zero mixture to be composted were taken immediately after pile construction, and shipped overnight to WESTON for analysis.

4.1.4 Operations Schedule

Piles 1 and 2 were maintained and sampled during the test period according to the operations schedule presented in Table 4-4.

4.2 RESULTS

4.2.1 Compost Temperature Data

The following temperature records were maintained for piles 1 and 2 throughout the study:

- Temperature recorder/logger: data printout from the 10 temperature probes every 4 hours.

- Hand-held landfill temperature probe: temperature profile of each pile taken during site visits.

- Ambient high and low air temperatures: recorded daily by BAAP (Figure 4-1).

Data obtained with the 10 temperature probes were considered the most representative of Piles 1 and 2 as five discrete regions of the piles were simultaneously monitored every 4 hours. Temperature data on piles 1 and 2 are presented as follows:

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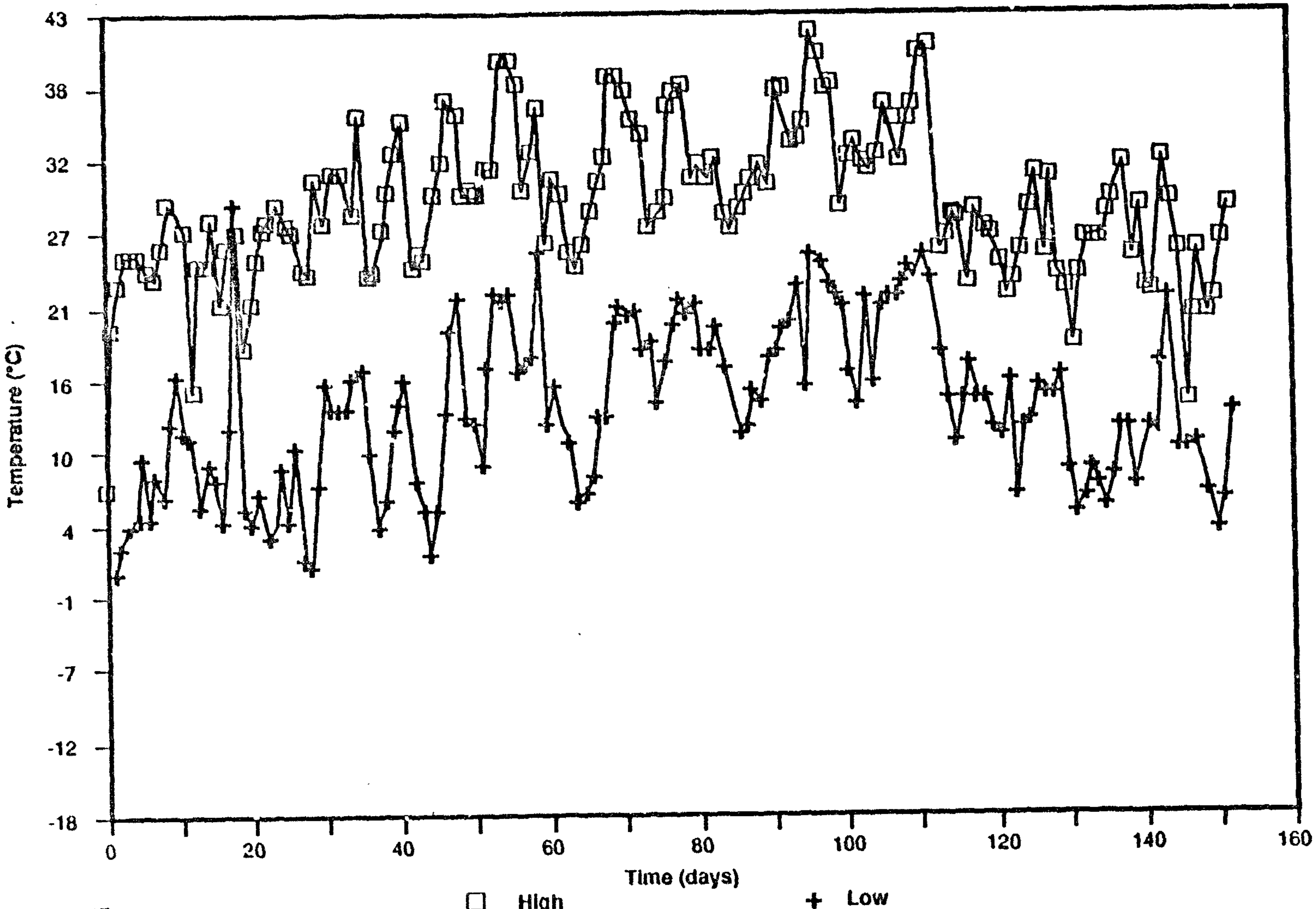
Table 4-4

Operation Schedule at BAAP
Compost Piles 1 and 2

Day	Date	Event
---	12 April	Soil excavated and sampled for NC.
0	29 April	Pile construction. Temperature control systems and recorders activated. Time 0 compost and nylon-bagged spiked concentrations sampled. Analyses: TOC, NC.
19	18 May	3-week samples taken. Analyses: TOC, NC.
39	7 June	6-week samples taken. Piles remixed and rewatered. One set of nylon-bagged spiked compost samples removed from each pile. Sump sampled. Analyses: NC.
54	22 June	8-week samples taken. Analyses: NC, TOC.
68	6 July	10-week samples taken. Exhaust air from blowers sampled. Analyses: NC, intermediates, TOC, TKN.
97	4 August	14-week samples taken. Remaining nylon-bagged spiked compost samples removed from each pile and shipped to WESTON for analysis. Analyses: NC.
151	26 September	Piles 1 and 2 disassembled. Samples taken of final compost mixture. Analyses: NC.



121-513T

Figure 4-1. High and low ambient temperatures - Phase I, BAAP composting project.

Figure	Data
4-1	High and low ambient air temperatures during Phase I of the BAAP demonstration.
4-2	Mean daily compost temperatures in pile 1.
4-3	Mean daily compost temperatures in pile 2.

4.2.2 Compost Moisture Content Data

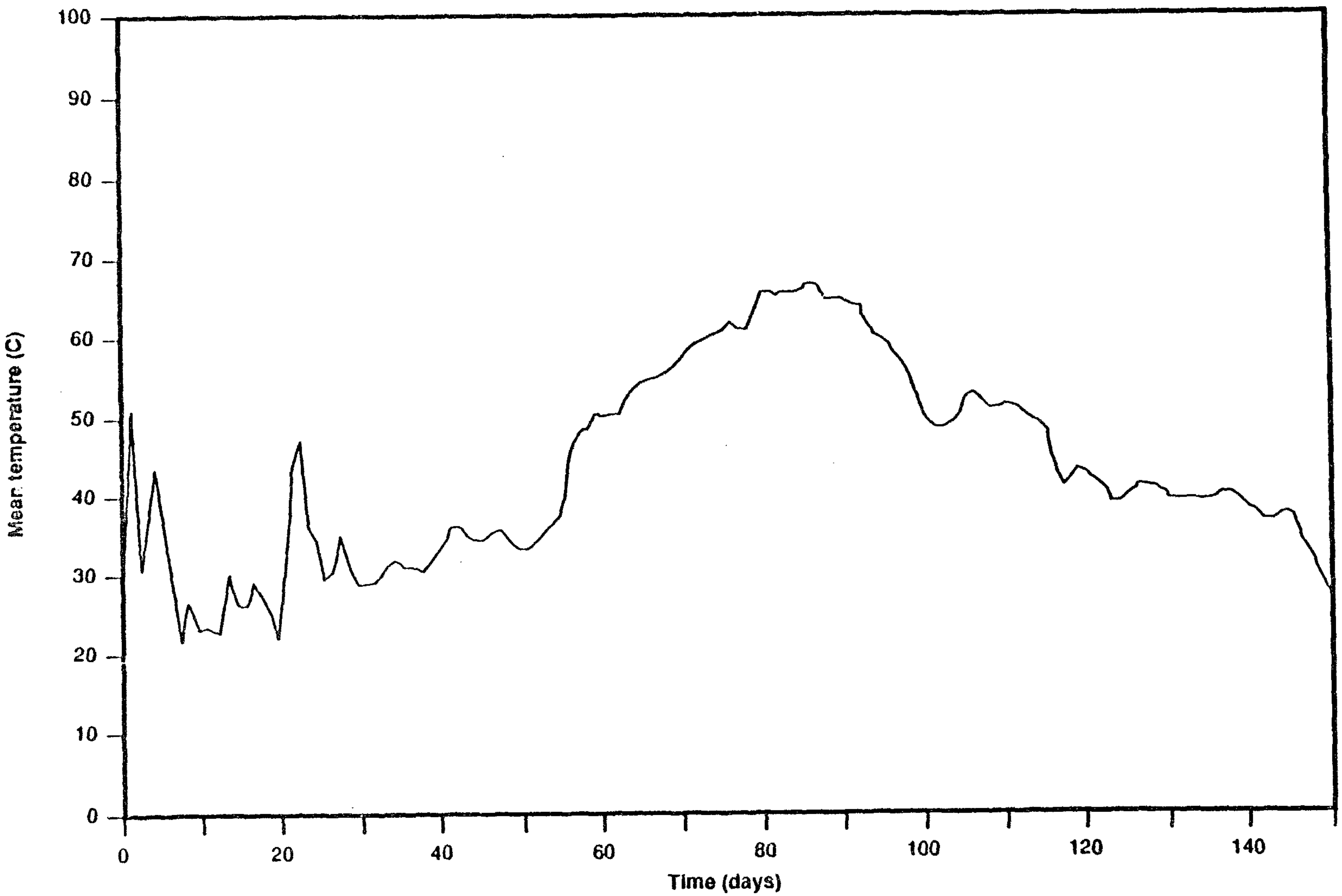
The moisture content of compost piles 1 and 2 ranged from 27 percent to 65 percent over the test period (see Table 4-5). Linear plots of the percent moisture in the compost versus time are presented in Figure 4-4.

4.2.3 Microbial Enumeration Data

The plate counts demonstrated the existence of significant heterotrophic microbial populations capable of growth at both 35°C and 55°C in both piles (see Table 4-6). Visual inspection of the colony morphologies provided an indication of the microbial diversity. Microbial colonies were characterized on the basis of size, color, shape (round versus variegated), and opacity. While both the thermophilic and mesophilic composts yielded viable populations of microbes, a greater diversity in microbial colonies was observed in the mesophilic populations. One morphology (white, opaque, round, approximately 1 mm in size) was observed in great quantities in the thermophilic microbial enumerations.

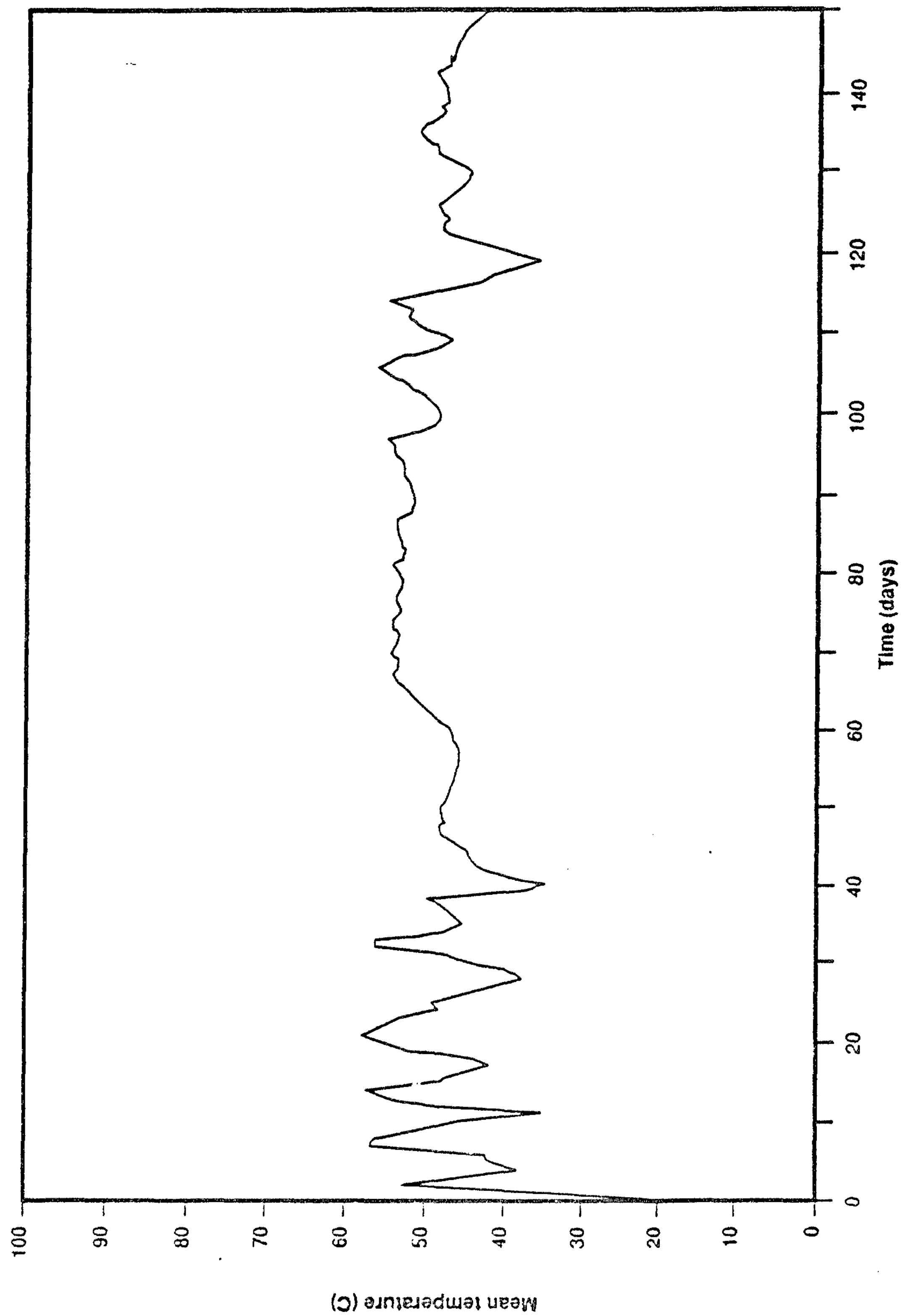
4.2.4 Fate of Nitrocellulose in Compost

The soil excavated from Dredge Spoil Basin No. 1 on 12 April 1988 contained an average of 18,800 ± 1,347 mg/kg of NC (based on 5 samples). Total NC concentrations at time zero were 908 mg/kg in pile 1 and 3,039 mg/kg in pile 2. The calculated theoretical NC content of piles 1 and 2 at time zero was 3,670 mg/kg and 3,608 mg/kg, respectively. After 152 days, at the termination of the study, mean total NC concentrations in piles 1 and 2 were 651 mg/kg and 54 mg/kg, respectively. These data represent mean percent reductions in NC concentrations of 28 percent in pile 1 and 98 percent in pile 2. However, the analytical data on day 70 and day 97 samples of pile 1 indicate that NC concentrations were reduced by 90.6 percent and 57.8



121-513J

Figure 4-2. Mean temperature in compost pile 1.


Mean temperature (C)
0
10
20
30
40
50
60
70
80
90
100
Time (days)
0
20
40
60
80
100
120
140

121-513K

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Table 4-5

Moisture Content of Compost Piles 1 and 2
(Mean Percent Moisture)

Week	Pile 1	Pile 2
0	60.8	61.1
3	47.8	50.4
6 (before remix)	61.5	47.1
(after remix)	65.3	64.6
8	65.9	65.4
10	61.3	64.1
14	48.0	56.5
22	27.3	50.6

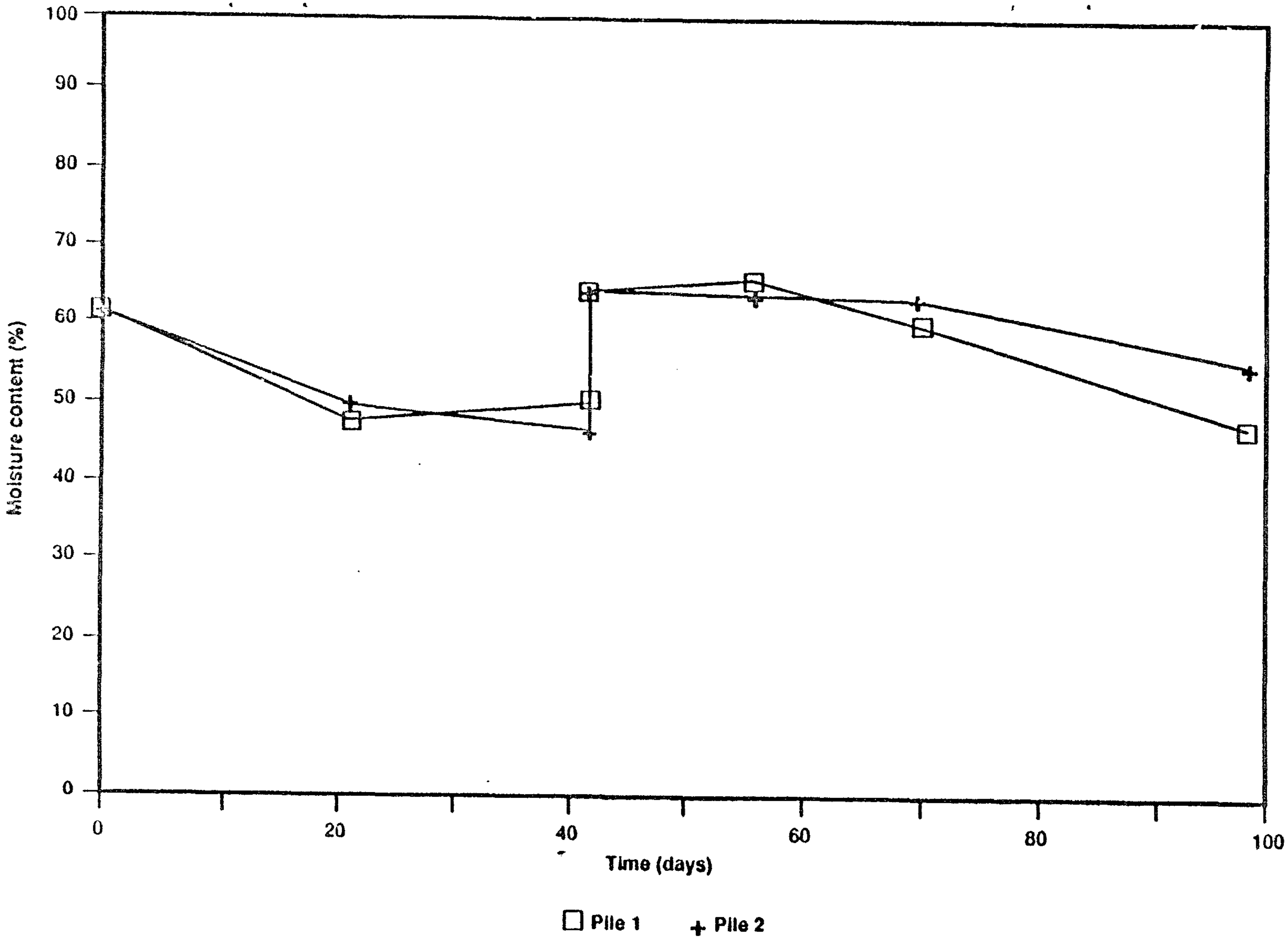

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Figure 4-4. Moisture content of compost piles 1 and 2.

Table 4-6

Microbial Enumeration Data: Compost Piles 1 and 2 (cfu/gram compost)

Week	Pile 1 (Mesophilic)	Pile 2 (Thermophilic)
0	4.1×10^7	1.4×10^5
3	10.3×10^7	3.3×10^7
6	54×10^7	*
8	24×10^7	*
10	1.6×10^7	*
14	8.6×10^7	*

*Plates covered by a white, translucent, variegated film of microbes.

percent, respectively. Linear plots of these data are presented in Figures 4-5 and 4-6. As illustrated by these figures, the concentration of extractable NC in pile 1 samples increased and peaked during the first 42 days of the test period and subsequently decreased to lower levels. The initial NC concentrations reported for the mesophilic pile (No.1) are believed to be in error.

Analysis of the bagged, spiked compost samples was performed at day 0, day 42, and day 97. However, the contents of some bags were lost due to disruption of the nylon. Analysis was performed in triplicate on the day 97 samples that were recovered. The results of the analyses on the bagged compost samples are presented in Table 4-7. Linear plots of the bagged NC concentrations versus time are presented in Figures 4-7 and 4-8.

TOC analysis revealed no significant decreases throughout the test period in Piles 1 or 2. At time zero, TOC in the mixture to be composted was 113,833 mg/kg. At the 3-week sampling point, the TOC values were 323,666 mg/kg and 348,333 mg/kg for Piles 1 and 2, respectively. At week 10, these values were 316,200 mg/kg (pile 1) and 351,200 mg/kg (pile 2).

As discussed in the schedule of operations, the exhaust from the blower system was sampled at two time-points. Analysis revealed that at 10 times the detection limits, no 2,4-DNT or 2,6-DNT was observed in the activated charcoal used to sample the emissions from the blower systems.

4.2.5 Nonquantitative Observations

Extensive fungal growth was observed in both piles 1 and 2, particularly in the regions farthest from the blowers. The compost covered with fungal mycelium was distinguished by its light gray color; tough, fibrous texture; and drier composition than the surrounding material. The fungus was primarily limited to the lower two thirds of the "heel" region in both of the piles. Extensive fungal growth was also observed in the nylon bags.

The piles, particularly pile 1, settled significantly by week 14. This settling reflected a decrease in the structural support provided by the bulking agents. This was confirmed by the decrease in porosity observed by sampling with the core auger. The peripheral layer of compost was dry and hard, but the central region was still quite warm and moist. This difference indicated that air flow through the compost matrix was restricted.

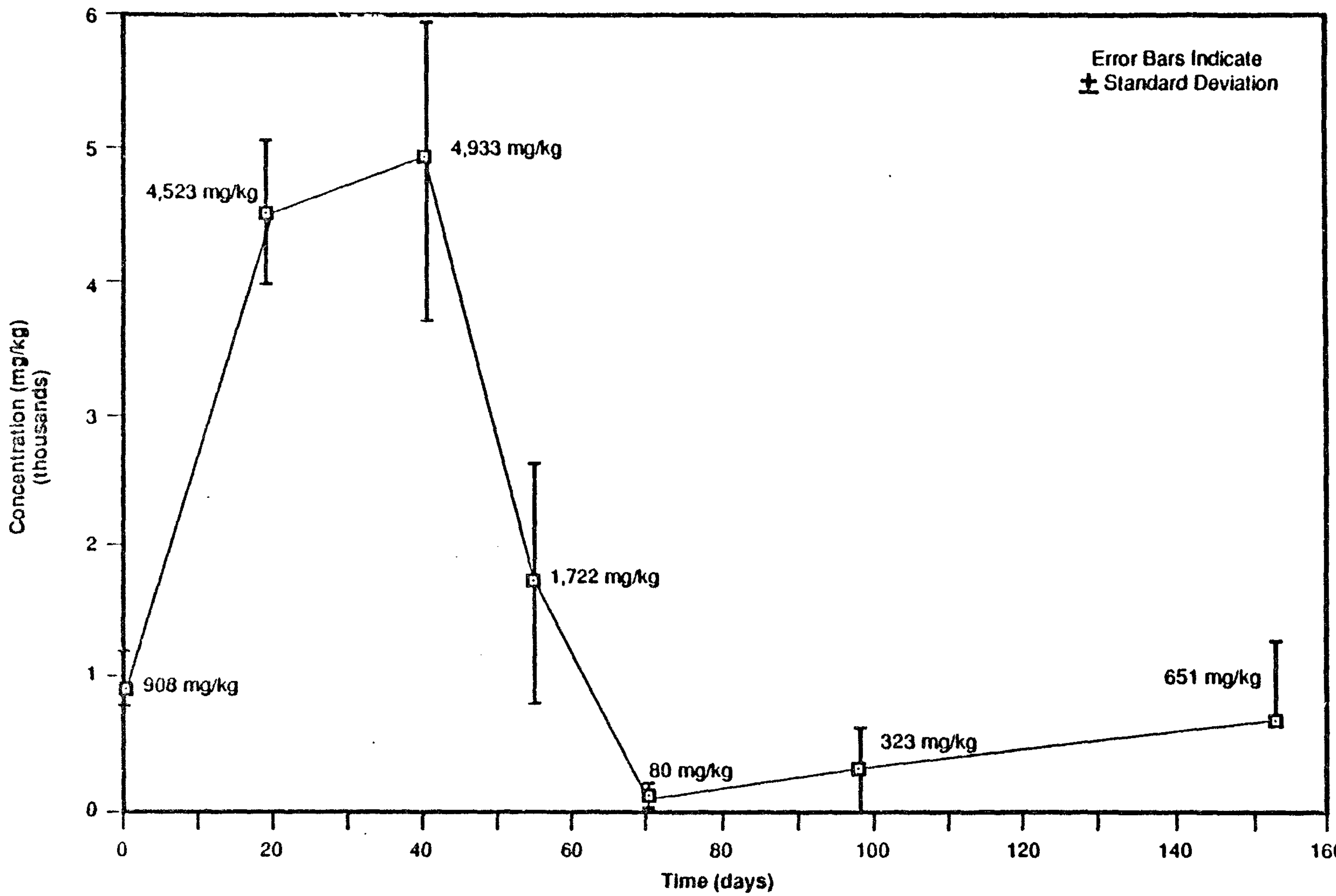

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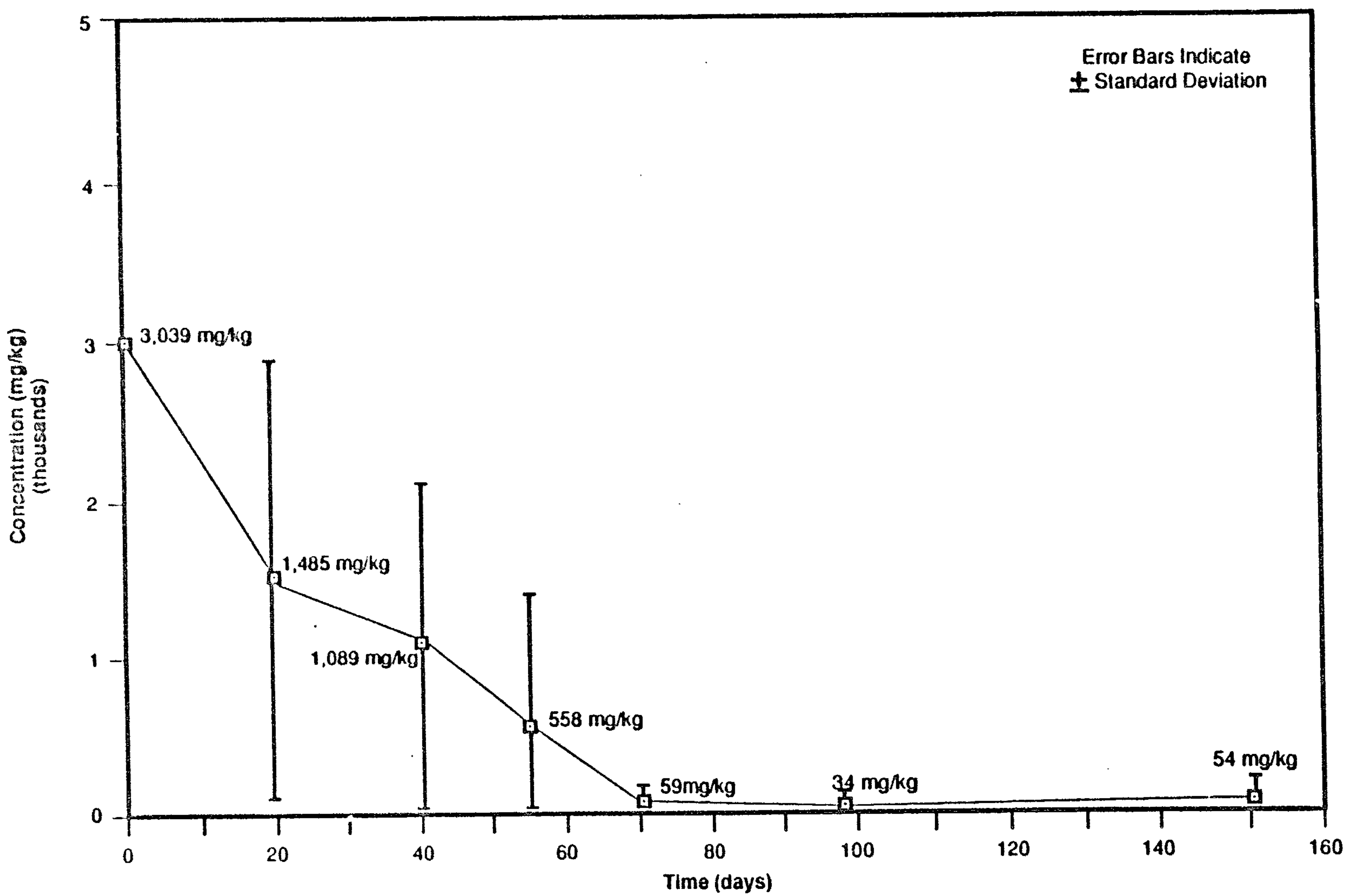
Figure 4-5. Concentration of nitrocellulose in compost pile 1.



121-513G

Figure 4-6. Concentration of nitrocellulose in compost pile 2.

WESTON

Table 4-7

Nitrocellulose Concentration in Bagged Compost Samples

Day	Pile	Theoretical NC (mg/kg)	NC Analysis (mg/kg)
0	1,2	30,000	6,447
		50,000	12,963
		75,000	15,568
		100,000	23,605
42	1		15,294
			38,676
			57,680
			67,198
42	2		209
			378
			587
			277
97	1		162
			386
			1,203
97	2		61
			40
			43
			61

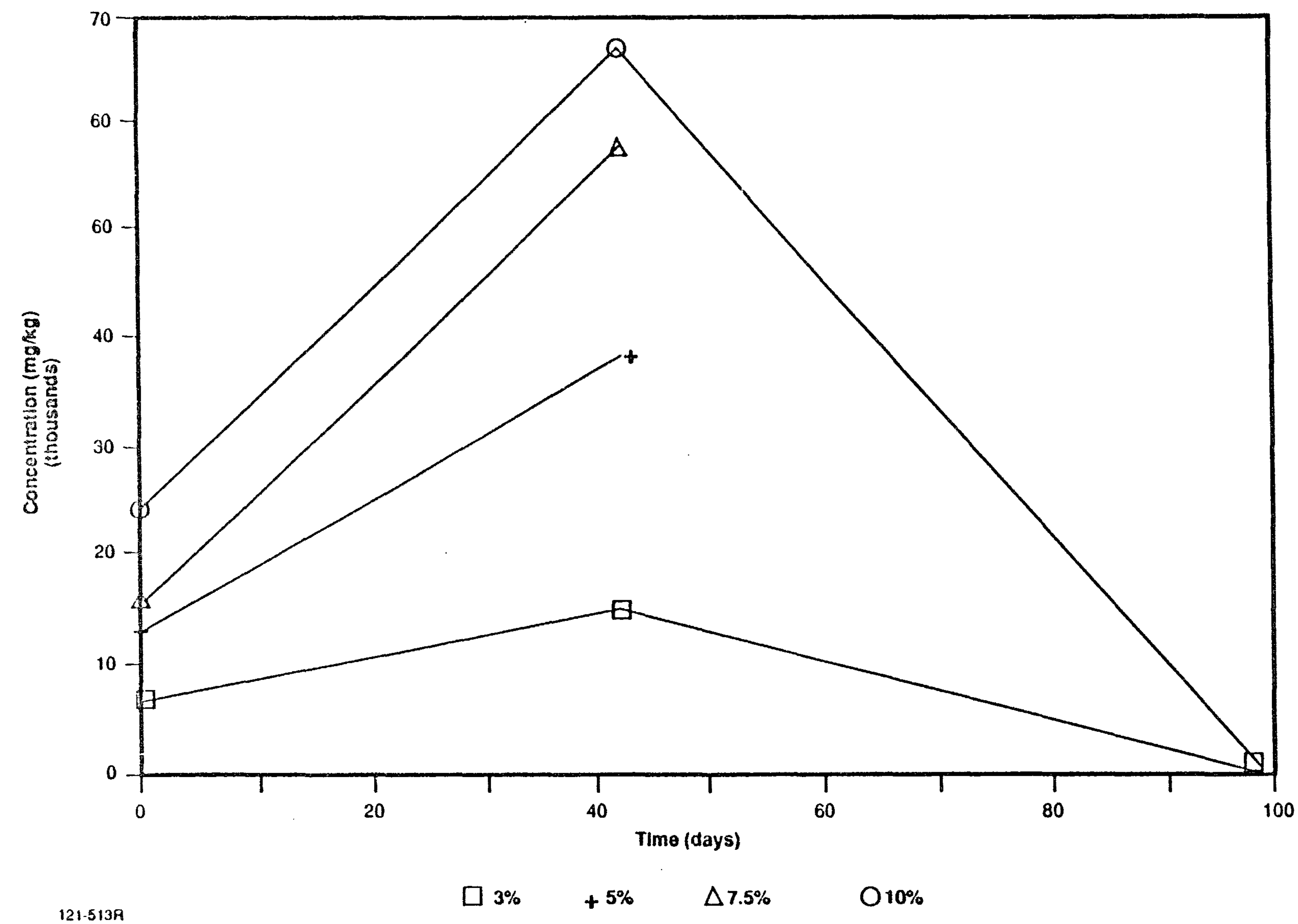


Figure 4-7. Concentration of nitrocellulose in bagged compost - pile 1.

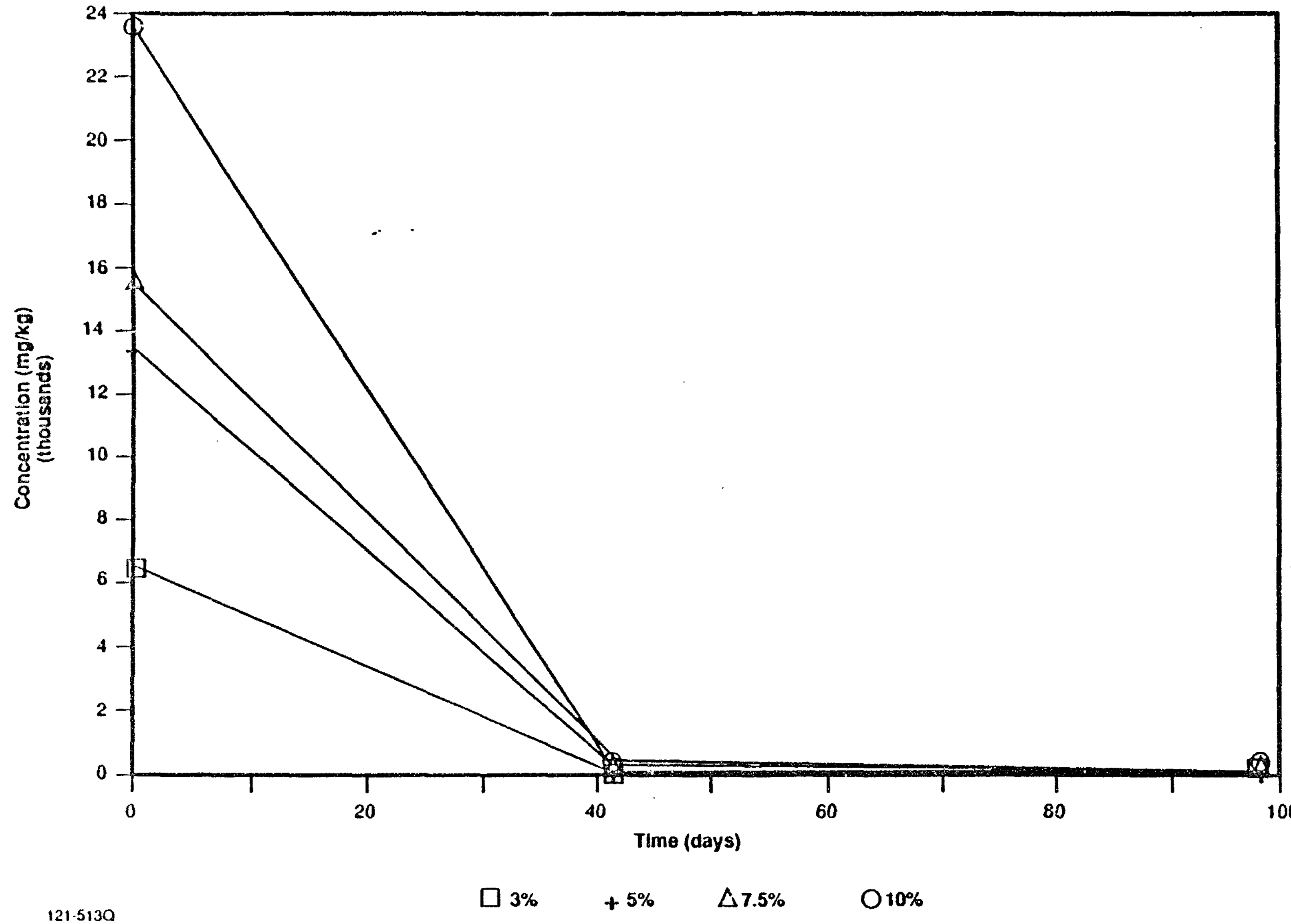


Figure 4-8. Concentration of nitrocellulose in bagged compost pile 2.

A change in odor and appearance of the compost matrix was observed on day 97. The manure-like smell associated with the center of the pile decreased noticeably, and a slight ammonia-like smell was detected from the deeper regions of pile 2. The compost became noticeably more homogeneous in appearance, with fewer large pieces of alfalfa or mulch present as the test period continued.

4.3 DISCUSSION

4.3.1 Fate of Nitrocellulose in Compost Piles 1 and 2

The initial concentrations of NC in both piles 1 and 2 were reduced during the 151-day test period (see Figures 4-5 and 4-6). This was particularly evident in pile 2, which exhibited a 98 percent reduction in extractable NC from time-zero. In contrast to these results, Pile 1 appeared to demonstate an initial increase in contaminant concentration from 908 mg/kg of NC to 4,933 mg/kg in the first 39 days. After 68 days, however, the NC concentration in pile 1 had been reduced to 80 mg/kg (91 percent reduction from time-zero), with a final NC concentration of 651 mg/kg at day 151 (28 percent reduction from time-zero). These discrepancies in the data for pile 1 may be due, in part, to error in the time-zero NC data or to inadequate homogenization of the compost materials for pile 1. The soil used was a cohesive, loamy soil that tended to bind and form lumps; this, compounded by the inherent viscidity of cow manure, may have caused small regions of higher or lower NC concentration within pile 1. However, the variation obtained from analyzing different samples indicated that, in general, good mixing and homogeneity were achieved. In addition, the rate of NC destruction can be expected to vary at different locations within the compost pile. Therefore, greater variation in NC content would be expected at earlier stages of the composting process. However, these possibilities seem to be inadequate to explain the low NC concentrations observed in pile 1 at time-zero. An exhaustive review of the sampling, analysis, and calculation records was conducted, but no errors were discovered to account for the pile 1 time-zero data.

The results of the NC-spiked nylon bag experiment were generally encouraging, particularly for the bags placed within pile 2 (thermophilic). Greater than 99 percent reduction was observed after 97 days in all of the bags placed within pile 2 (see Figure 4-8). However, the bags placed within pile 1 displayed an initial increase in extractable NC, further supporting the idea that the time-zero NC data were in error (see Figure 4-7). Total NC degradation in pile 1 bags was greater than 90 percent after 97 days. As can be seen from these results, NC levels as high as 10 percent do not appear inhibitory, and it appears probable that NC could be composted at higher levels than those tested.

Both the rate and extent of contaminant degradation in compost piles 1 and 2 indicated that the thermophilic temperature range appears to be superior to the mesophilic temperature range. However, the mesophilic and thermophilic temperature ranges were not able to be maintained as distinctly as desired in piles 1 and 2. Therefore, this is only a tentative conclusion.

4.3.2 Temperature/Aeration Control and Monitoring

Temperature in pile 1 (mesophilic) reached higher levels than desired after day 55. Although the blower ran constantly in an attempt to cool the pile, the temperature would not decrease to the desired level.

Two factors contributed to the difficulty in maintaining a constant temperature in pile 1. One, the formation of "hot spots" (discrete regions of increased temperature) was observed in both piles throughout the test period. If the thermistor probe, which relayed temperature data to the blower control system, was located in a cooler region than the surrounding area, the blower would not be temperature-activated and the overall pile temperature would increase. Conversely, if the probe was located in a "hot spot," the blower system would be activated continually, thus potentially cooling the pile unnecessarily. On one occasion, the thermistor probe was located within a "hot spot," approximately 12 inches in diameter while the rest of the pile was substantially cooler than desired.

The second factor affecting pile temperature was the difficulty in maintaining porosity within the compost matrix. A noticeable "settling" of the piles, particularly in pile 1, was observed at the 14-week sampling point. This compaction and loss of porosity obstructed air flow within the pile, thus decreasing the blower's ability to maintain desired temperatures.

The decrease in porosity was not uniform throughout the pile and resulted in uneven air flow. It was observed during the pile remix that the compost between the aeration piping was noticeably wetter than the surrounding compost. This was indicative of reduced evaporative moisture loss caused by a decrease in air flow.

The top portions of both piles were generally warmer than the lower regions. Two nonexclusive explanations may account for these observations. First, air will tend to follow the route of least resistance through the compost pile by traveling the shortest possible distance which, in the case of the compost piles, would be through the base of the piles. The cooling effects resulting from such air flow would lead to lower temperatures at the pile base compared to the top. Second, heat generated in the base of the pile will tend to rise through the matrix, thus increasing the accumulation of heat in upper regions of the pile.

4.3.3 Compost Moisture Content and Remixing

Periodic moistening of the compost was required to maintain an appropriate moisture content, particularly during the unusually dry and hot summer months in which Phase I of the BAAP project was active. The evaporative moisture loss caused by hot and dry ambient air through the piles was potentially substantial. Periodic remixing of the compost to provide moisture also facilitated the efficiency of the composting process. Remixing homogenized the compost and maximized contact of the soil contaminants with the active microbial biomass. Remixing also created a more homogeneous temperature profile within the pile by breaking up clumps that formed as the compost mixture dried.

4.3.4 Microbial Population

The data obtained from the microbial enumerations suggest several trends. The overall species diversity appeared greater in mesophilic compost samples than in samples obtained from the thermophilic compost enumerations. However, the same morphological type was also observed repeatedly in the mesophilic compost samples. The microbial population density tended to be slightly greater in the mesophilic pile while the rate and extent of NC degradation was greater in the thermophilic pile. These results, however, may reflect selectivity exerted during the isolation and enumeration of the compost microflora.

SECTION 5

COMPOST PILES 3 AND 4

5.1 COMPOST PILE DESIGN, CONSTRUCTION, AND OPERATION

5.1.1 Test Variables

The test variable in compost piles 3 and 4 was the degree of soil loading within each pile. Soil loading was increased from the 19 percent used in piles 1 and 2 to 22 percent in pile 3 and 32.5 percent in pile 4. These parameters were designed to investigate the reduction of NC at higher concentrations and the ability to effectively compost at higher soil loading rates. Both piles were planned for operations in the thermophilic temperature range (55 $\pm$4°C) based upon the degradation rates observed in Phase I.

5.1.2 Test Soil and Bulking Agents

The mixture to be composted in piles 3 and 4 consisted of BAAP soil excavated from Dredge Spoil Basin 1 on 26 September 1988 (see Table 3-1), feed, woodchips, unchopped alfalfa, and cow manure. The NC content of this soil was 17,027 $\pm$4,358 mg/kg. The woodchips and whole alfalfa were used in Phase II to increase the porosity of the compost matrix. Bulk density measurements were obtained for each of the pile components using the same method as that employed in Phase I. The bulk densities of the pile components are presented in Table 5-1.

Based on the results observed in Phase I of the BAAP project, data from the field demonstration at LAAP, and desired soil loading rates of approximately 25 percent in pile 3 and approximately 35 percent in pile 4, a materials balance was developed for the pile components. The initial NC concentration in the test soil was 17,027 $\pm$4,358 mg/kg, a concentration that was reduced by dilution when the bulking agents were mixed with the soil. To further investigate the degradation potential at higher levels of NC concentration, bagged samples of spiked compost were prepared for placement in one of the piles. Spiked NC concentrations in this phase of the study were approximately 5, 15, 30, 60, and 80 percent by weight. Four sets of triplicate samples of each concentration were placed in nylon bags, which were enclosed in a polyethylene mesh sleeve to reduce the risk of disruption of the bags.

Tables 5-2 and 5-3 present the materials balance used for piles 3 and 4, respectively.

Table 5-1

Bulk Densities of Materials
Used in Compost Piles 3 and 4

Material	Mean Bulk Density (lb/yd^3)
Soil	1,701.6
Manure	1,564.5
Alfalfa	173.4
Feed	1,080.6
Woodchips	610.5

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Table 5-2

Materials Balance of Compost Pile 3

Material	Volume (yd^3)	Mass (lb)	Percent Volume	Percent Mass
Soil	1.50	2,550	11.8	22.2
Alfalfa	5.2	904	40.9	7.9
Feed	1.6	1,776	12.6	15.5
Woodchips	0.7	440	5.5	3.8
Manure	3.7	5,800	29.1	50.6
Total	12.7	11,470	100.0	100.0

Note: Volume measurements are approximate; materials were measured by weight.

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Table 5-3

Materials Balance of Compost Pile 4

Material	Volume (yd^3)	Mass (lb)	Percent Volume	Percent Mass
Soil	2.6	4,400	19.3	32.5
Alfalfa	4.1	710	30.3	5.2
Feed	1.6	1,700	11.9	12.6
Woodchips	1.4	830	10.4	6.1
Manure	3.8	5,900	28.1	43.6
Total	13.5	13,540	100.0	100.0

Note: Volume measurements are approximate; materials were measured by weight.

5.1.3 Compost Mixing/Pile Construction

Piles 3 and 4 were constructed in the following sequence:

- Contaminated soil was excavated on 26 September 1988, homogenized using the front-end loader, piled on the concrete mixing pad, and covered.

- Pile construction was initiated on 27 September 1988.

- Bulk densities were determined for each of the pile components.

- Woodchip bases (6 feet x 10 feet x 4 inches) were constructed, aeration piping laid on top, and an additional 4 inches of woodchips placed over the piping. The bases were constructed to be smaller than in Phase I to form a more compact pile that would retain heat better during cold weather. Pipe connections were secured with snap connectors and duct tape. Nonperforated pipe was used from the blowers through the "T" junction and perforated piping was used through the junction to the capped ends (see Figure 3-2). Straw bales were placed along all sides of the pile to contain the compost. However, in Phase II, the bales were laid on the widest side and stacked two high to better retain heat and contain the mass of the pile.

- Soil, feed, alfalfa, woodchips, and 30 pounds of P:N:K (13/13/13) fertilizer were mixed in the Knight Reel Auggie until a homogeneous mixture was achieved. The computerized scale was used to record the individual component weights.

- The mixer was pulled to the USDFRC, where liquid cow manure was pumped in the mixer. The slurry was added until visual inspection revealed saturation of the components.

- The mixer was returned to the test site, where a hydraulic ramp on the mixer emptied the contents into the bucket of a front-end loader. The compost was then transported to the appropriate test pad.

- Three sets of the nylon- and polyethlene-bagged compost samples were placed at mid-depth in pile 3. The sets were placed in the heel region, and the set designed for removal at pile takedown was placed in the center. The bags were then covered with the remaining compost mixture. Nylon tags with the bag identification were placed within each bag, and also at the ends of attached nylon strings which were run out of the side of the pile to facilitate sampling. The fourth set of bags was placed on ice and shipped to WESTON via overnight freight for time-zero analysis.

- The remainder of the mixture to be composted was placed onto each pile, and straw bales placed along the open side.

- Thermocouple and thermistor probes were placed at predetermined regions in each pile, thus providing synonymous data for each sector within the two piles. The 10-channel temperature recorder/logger was set at time-zero and programmed to print out data every 4 hours.

- Each pile was covered with 5 cubic yards of sawdust plus 1 cubic yard of softwood mulch to provide insulation.

- The thermistor-activated temperature controller was set to timer operation (60 seconds per 1,300-second cycle)

- Samples of the time-zero mixture to be composted were taken immediately after pile construction, and shipped overnight to WESTON for analysis.

5.1.4 Operations Schedule

Piles 3 and 4 were maintained and sampled during the test period according to the operations schedule presented in Table 5-4.

5.2 RESULTS

5.2.1 Compost Temperature Data

The following temperature records were maintained for piles 3 and 4 in Phase II of the BAAP study:

- Ambient high and low air temperatures: recorded daily by BAAP (Figure 5-1).

- Hand-held landfill temperature probe: temperature profile of each pile taken during site visits.

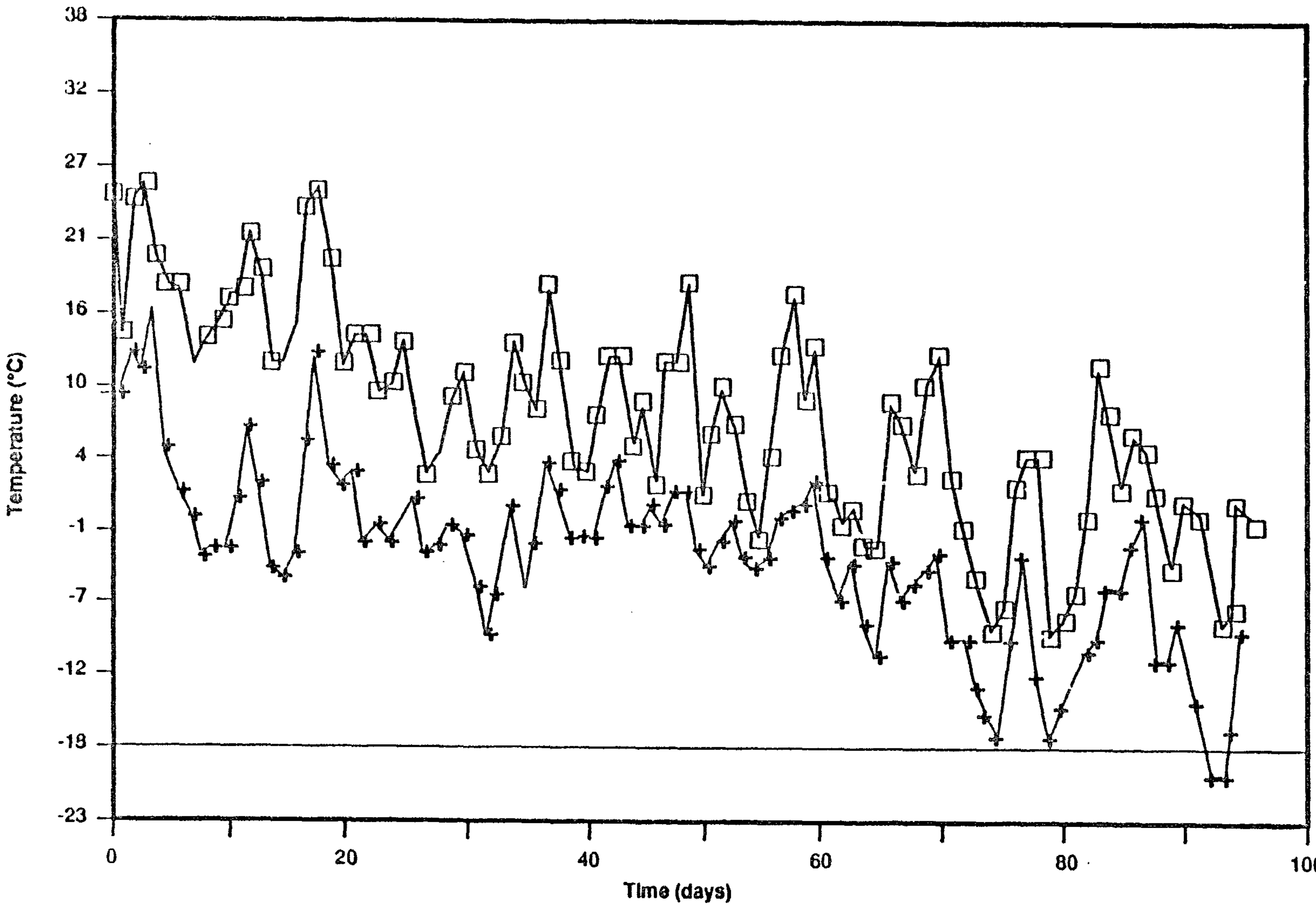
- Temperature recorder/logger: data printout from the 10 temperature probes every 4 hours.

A lightning storm on 15 November 1988 (day 97) rendered the temperature recording system inoperable. Temperature data were collected every two to three days from that time to the termination of the study (6 January 1989) by using the hand-held temperature probe. A 9-point temperature profile of each pile was taken manually, the data recorded on-site and the results telephoned to WESTON personnel. Data obtained with the 10 temperature probes were considered the most representative of conditions within the piles as five discrete regions of the pile were simultaneously monitored every 4 hours for 97 days.

Table 5-4

Operation Schedule at BAAP Compost Piles 3 and 4

Day	Date	Event
---	26 September	Soil excavated and sampled for NC.
0	27-28 September	Pile construction. Temperature control systems and recorders activated. Time-zero compost and nylon-bagged spiked concentrations sampled for NC.
29	26 October	4-week samples taken. One set of bags removed from pile 3.
49	15 November	Piles remixed and rewatered with sump contents. 7-week samples taken of remixed compost, and one set of bags removed from pile 3. Analysis: NC.
101	6 January	14-week samples taken. Remaining set of bags removed from pile 3. Analysis: NC.
112	17 January	Piles 3 and 4 disassembled.



121-513O

Figure 5-1. High and low ambient temperatures - Phase II, BAAP composting project.

Temperature data on piles 3 and 4 are presented as follows:

Figure	Data
5-1	High and low ambient air temperatures during Phase II of the BAAP project.
5-2	Mean daily compost temperatures in pile 3 (thermophilic).
5-3	Mean daily compost temperatures in pile 4 (thermophilic).
5-4	Mean daily compost temperatures in pile 3 versus pile 4.

5.2.2 Compost Moisture Content Data

The moisture content of compost piles 3 and 4 ranged from 58.7 percent to 26.2 percent (see Table 5-5). Linear plots of the percent moisture in the compost versus time are presented in Figure 5-5. Raw data on compost moisture content are presented in Table C-10 in Appendix C.

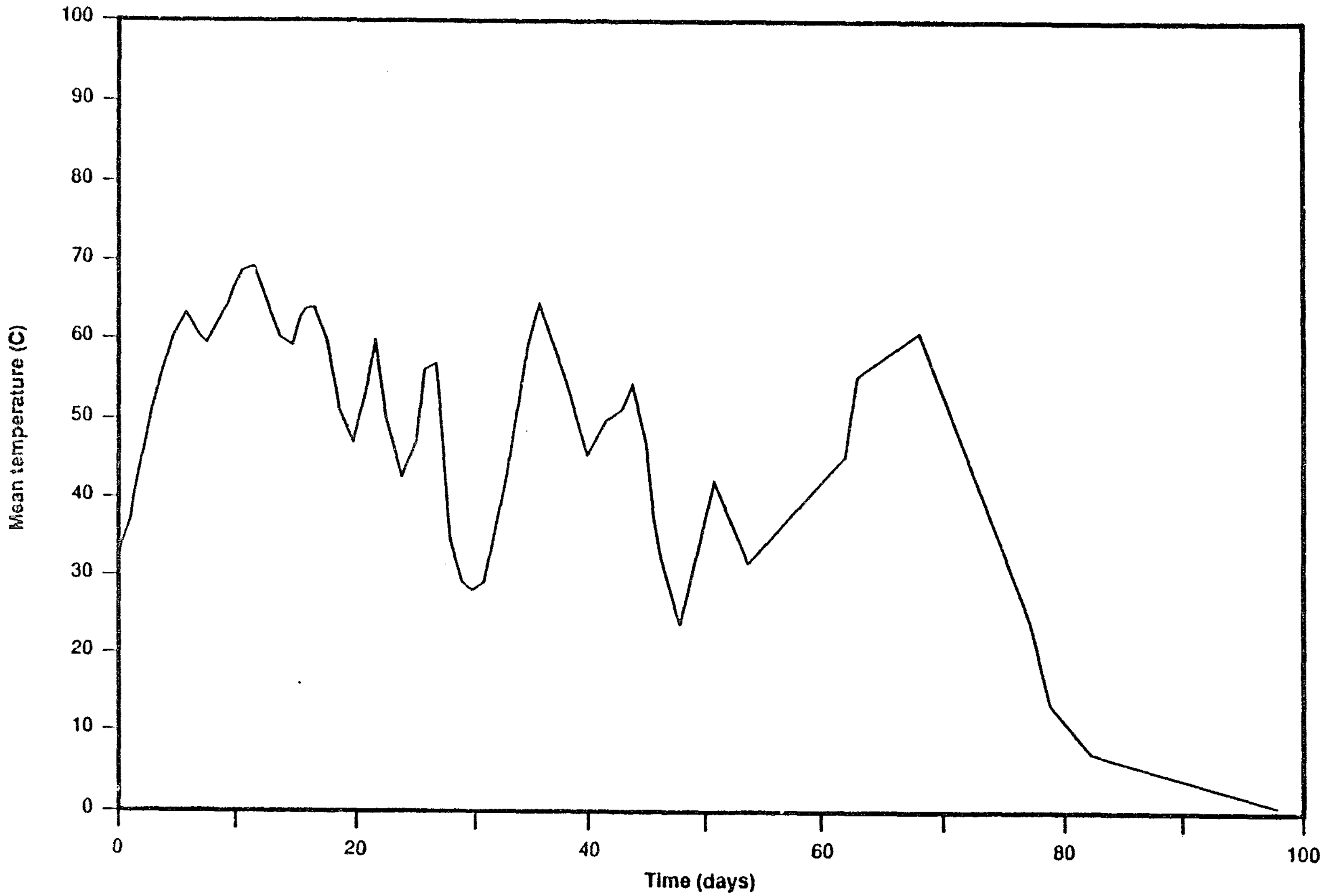
5.2.3 Microbial Enumeration Data

The plate counts demonstrated the existence of an indigenous microflora capable of growth both in the thermophilic temperature range and at higher levels of NC concentration (see Table 5-6). Microbial colonies were characterized on the basis of size, color, shape (round versus variegated, etc.), and capacity. Enumeration of the colony morphologies observed provided an indication of the microbial diversity. One morphology in particular (white, opaque, round, approximately 2 mm in size) was consistently observed in great quantities.

5.2.4 Fate of Nitrocellulose in Compost

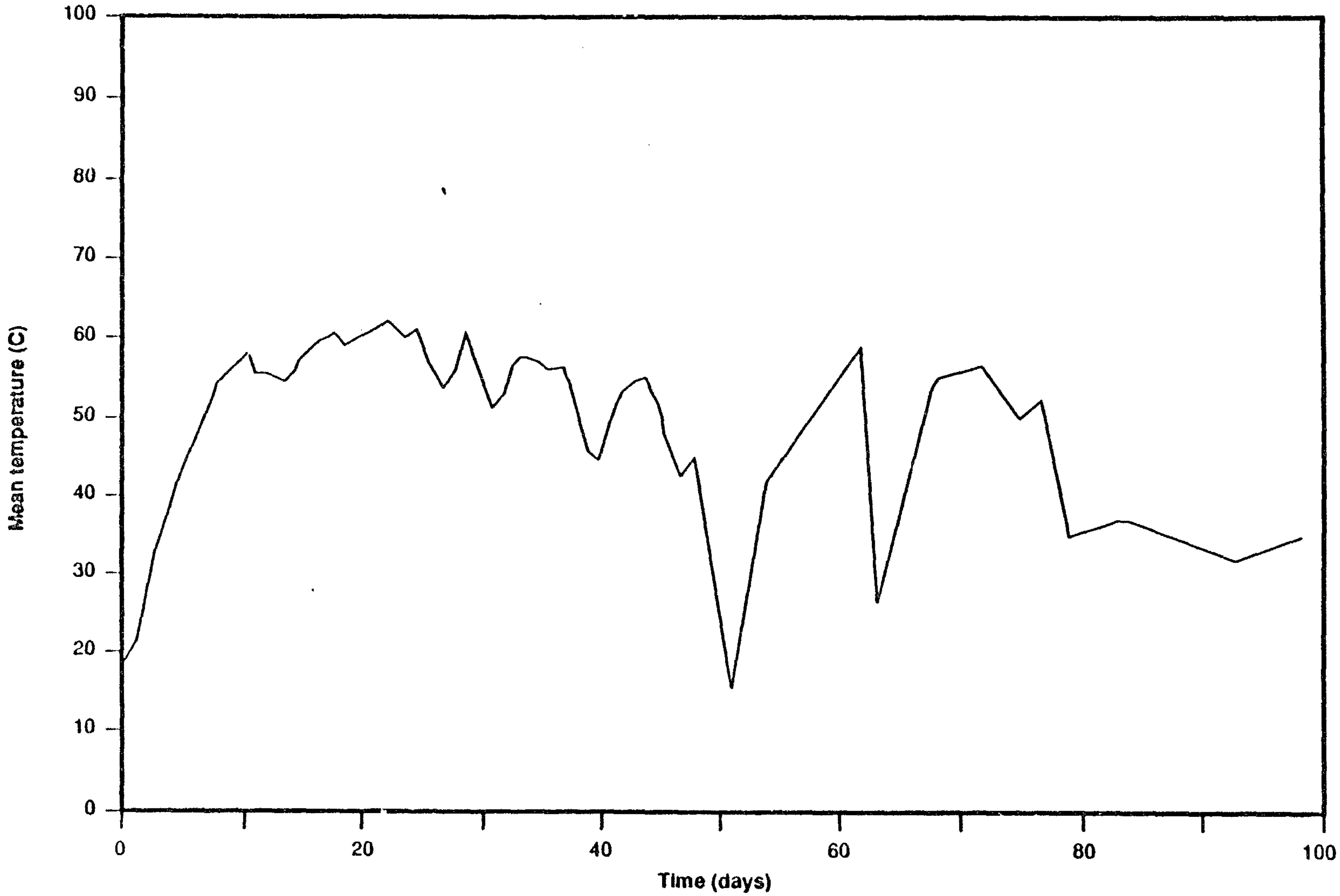
The soil excavated from Dredge Spoil Basin No. 1 on 26 September 1988 contained an average of 17,027 $\pm$4,358 mg/kg of NC. Total NC concentrations at time-zero were 7,907 mg/kg in pile 3 and 13,086 mg/kg in pile 4. After 101 days, at the termination of the study, mean total NC concentrations in piles 3 and 4 were 30 mg/kg and 16 mg/kg, respectively. These data represent mean percent reduction in NC concentrations of 99.6 percent in pile 3 and 99.9 percent in pile 4. Linear plots of these data are presented in Figures 5-6 and 5-7.

Analysis of the bags of spiked compost was performed at day 0, day 29, day 49, and day 101. The analytical results are presented in Table 5-7. As illustrated by Figures 5-8 through 5-12, the contaminated levels were significantly reduced in all but the 80-percent NC-spiked samples. Very little degradation



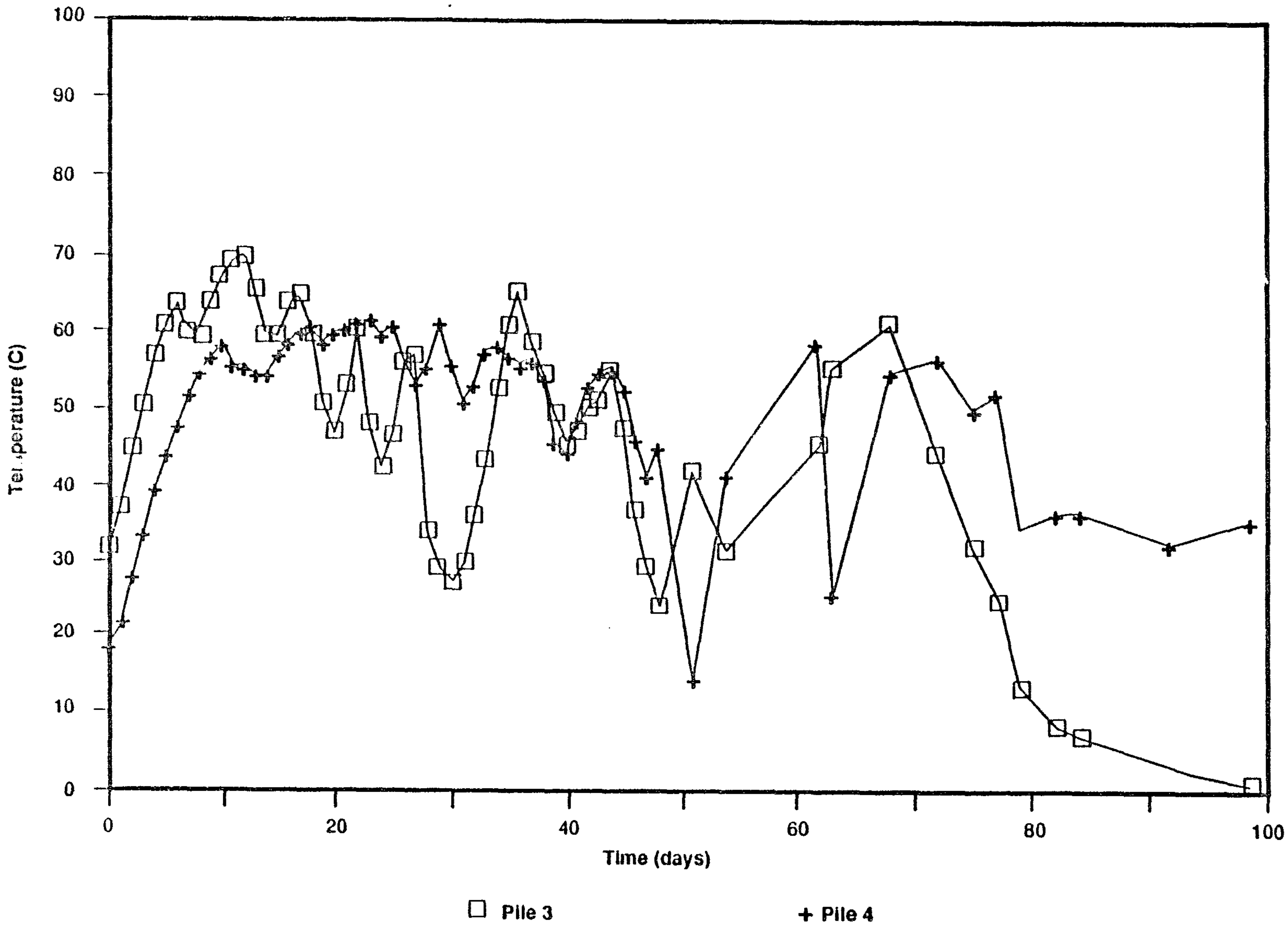
121-513L

Figure 5-2. Mean temperature in compost pile 3.



121-513M

Figure 5-3. Mean temperature in compost pile 4.



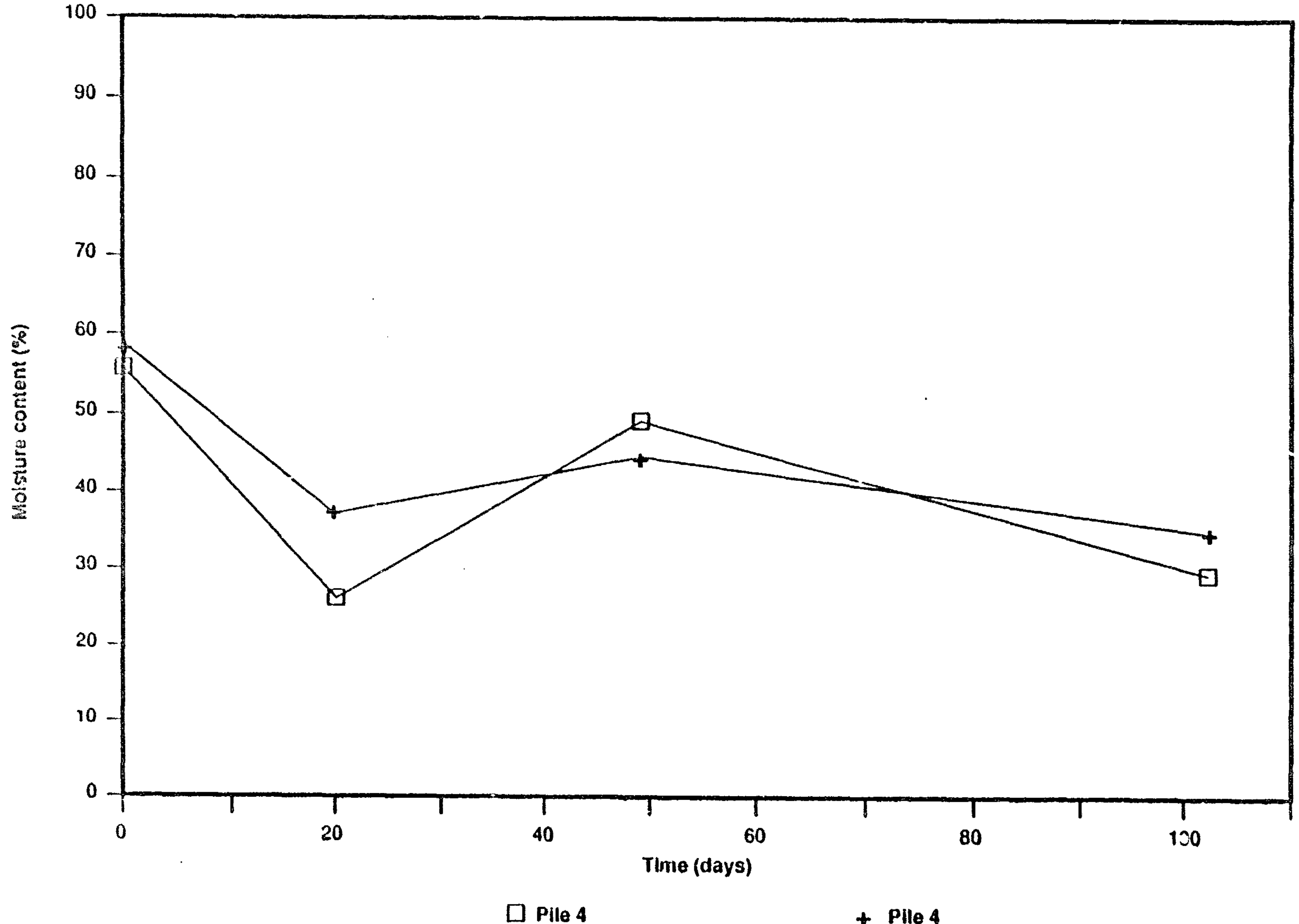
121-513N

Figure 5-4. Mean temperature in compost piles 3 and 4.

Table 5-5

Moisture Content of Compost Piles 3 and 4
Mean Percent Moisture

Week	Pile 3	Pile 4
0	55.7	58.7
4	26.2	37.3
7 (after remix)	48.8	44.6
14	29.2	34.0



121-513P

Figure 5-5. Moisture content of compost piles 3 and 4.

WESTON

Table 5-6

Microbial Enumeration Data
Compost Piles 3 and 4

	Pile 3		Pile 4	
Week	cfu/gram Compost	No. of Colony Types	cfu/gram Compost	No. of Colony Types
0	1×10^6	2	$1.2 \times. 10^6$	2
4	3×10^6	3	5.5×10^7	4
7	1.5×10^7	5	5.0×10^7	5

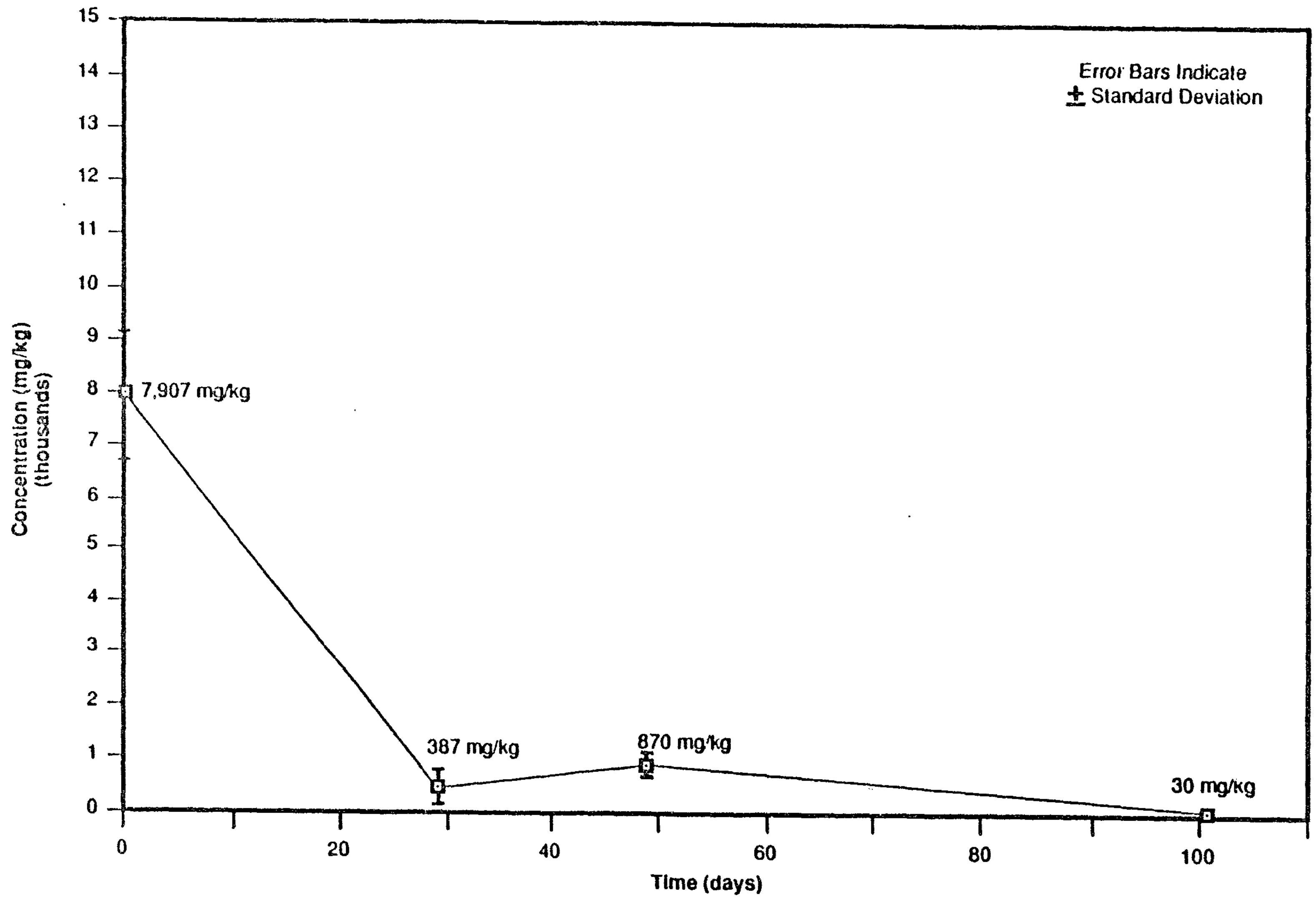


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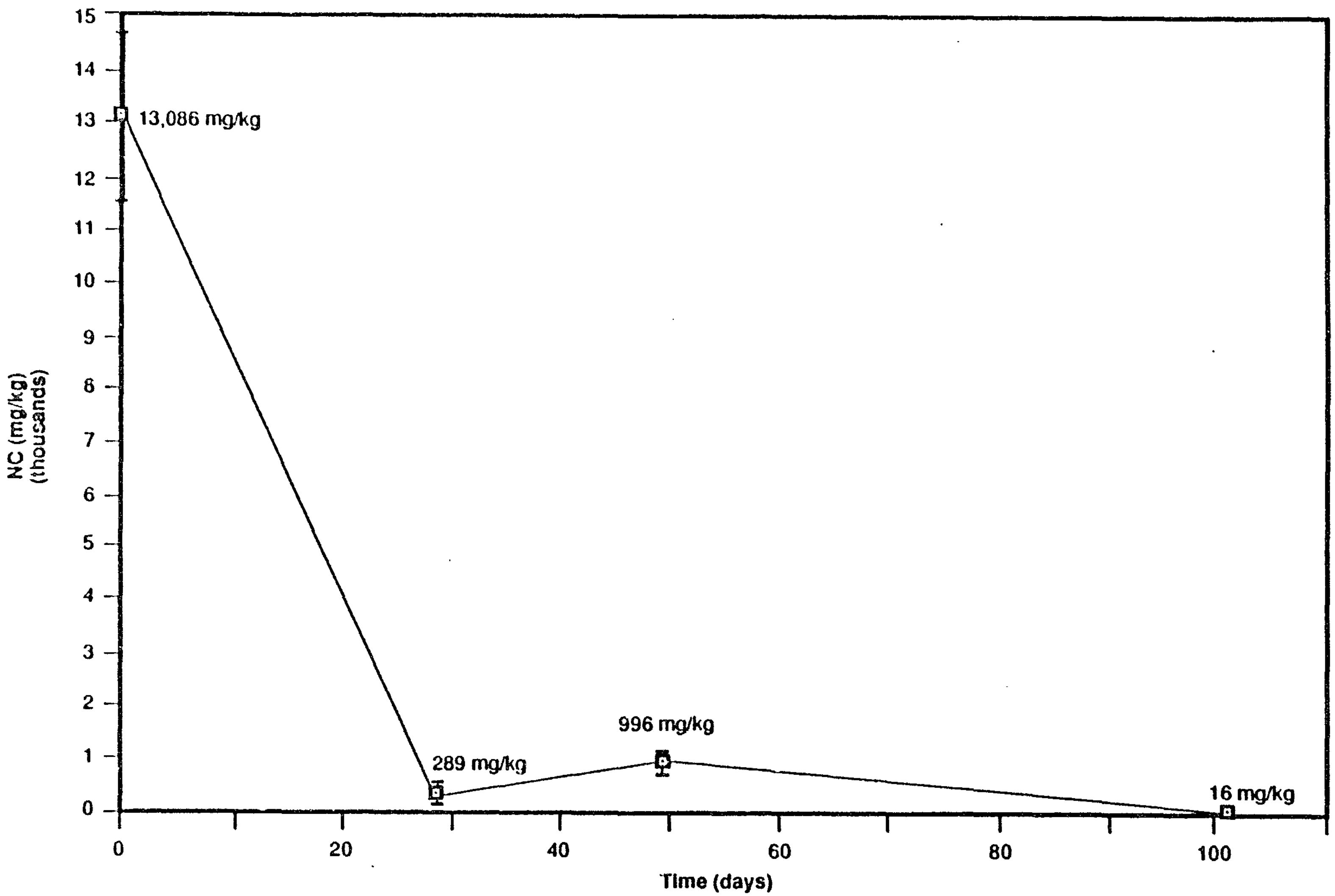
Figure 5-6. Concentration of nitrocellulose in compost pile 3.



121-513 I

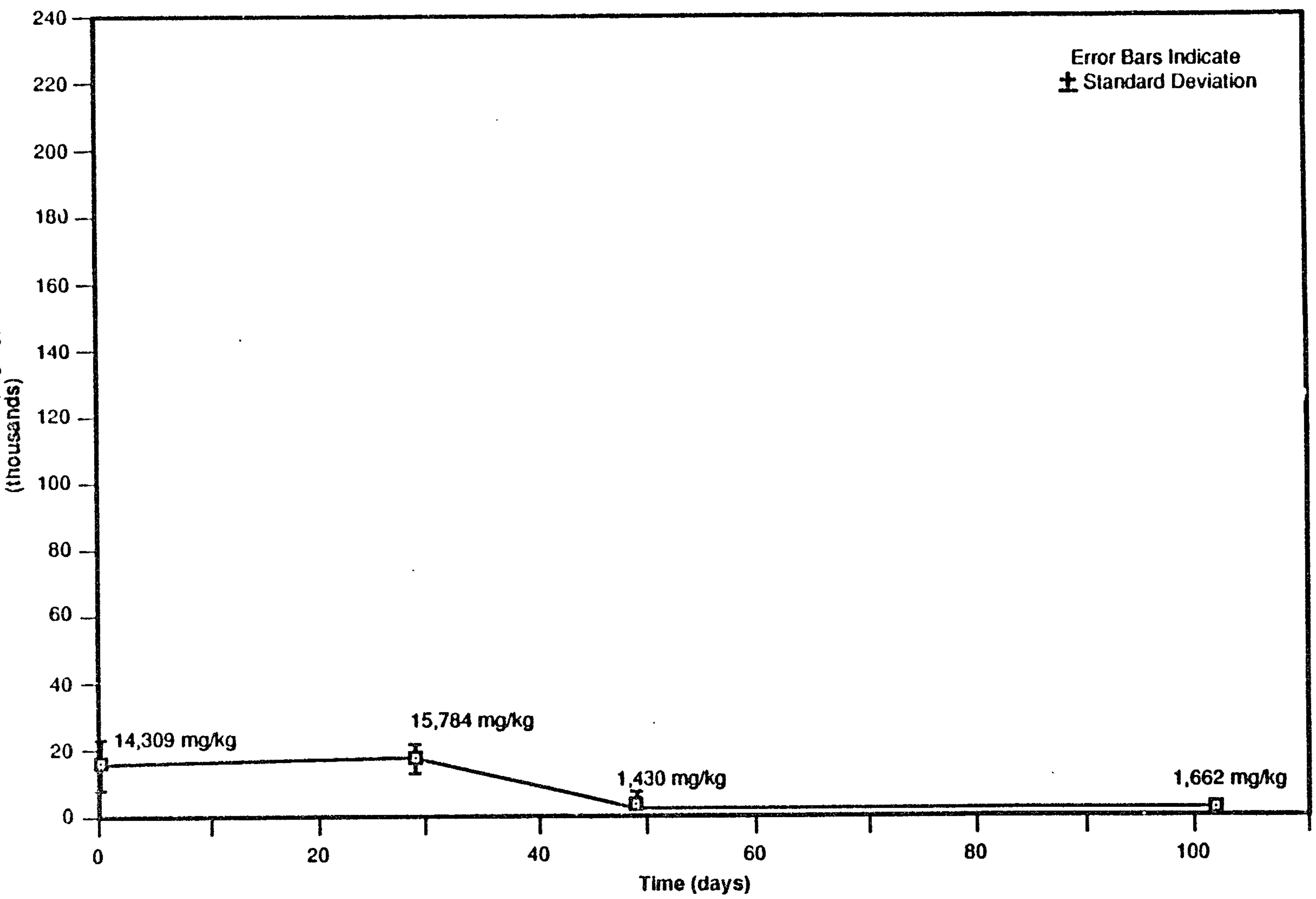
Figure 5-7. Concentration of nitrocellulose in compost pile 4.

WESTON

Table 5-7

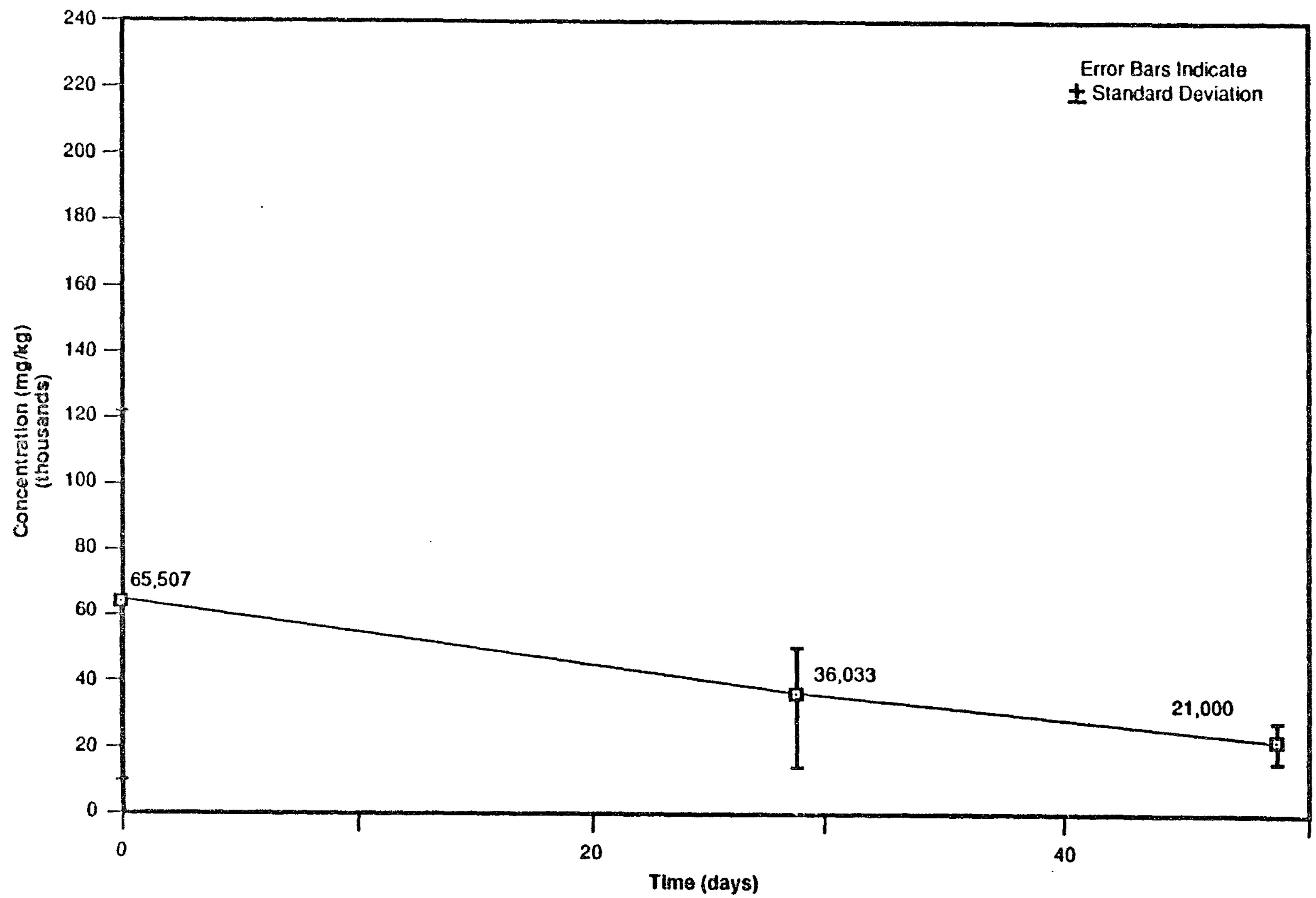
Nitrocellulose Concentration in Bagged Compost Samples - Pile 3

Day	Theoretical NC (mg/kg)	Analyzed NC (mg/kg)
0	50,000	14,309
	150,000	65,507
	300,000	114,527
	600,000	218,627
	800,000	164,436
29		15,784
		36,033
		73,611
		219,712
		158,724
49		1,430
		21,000
		5,199
		144,297
		(no data)
101		1,662
		(no data)
		2,455
		68,811
		203,003



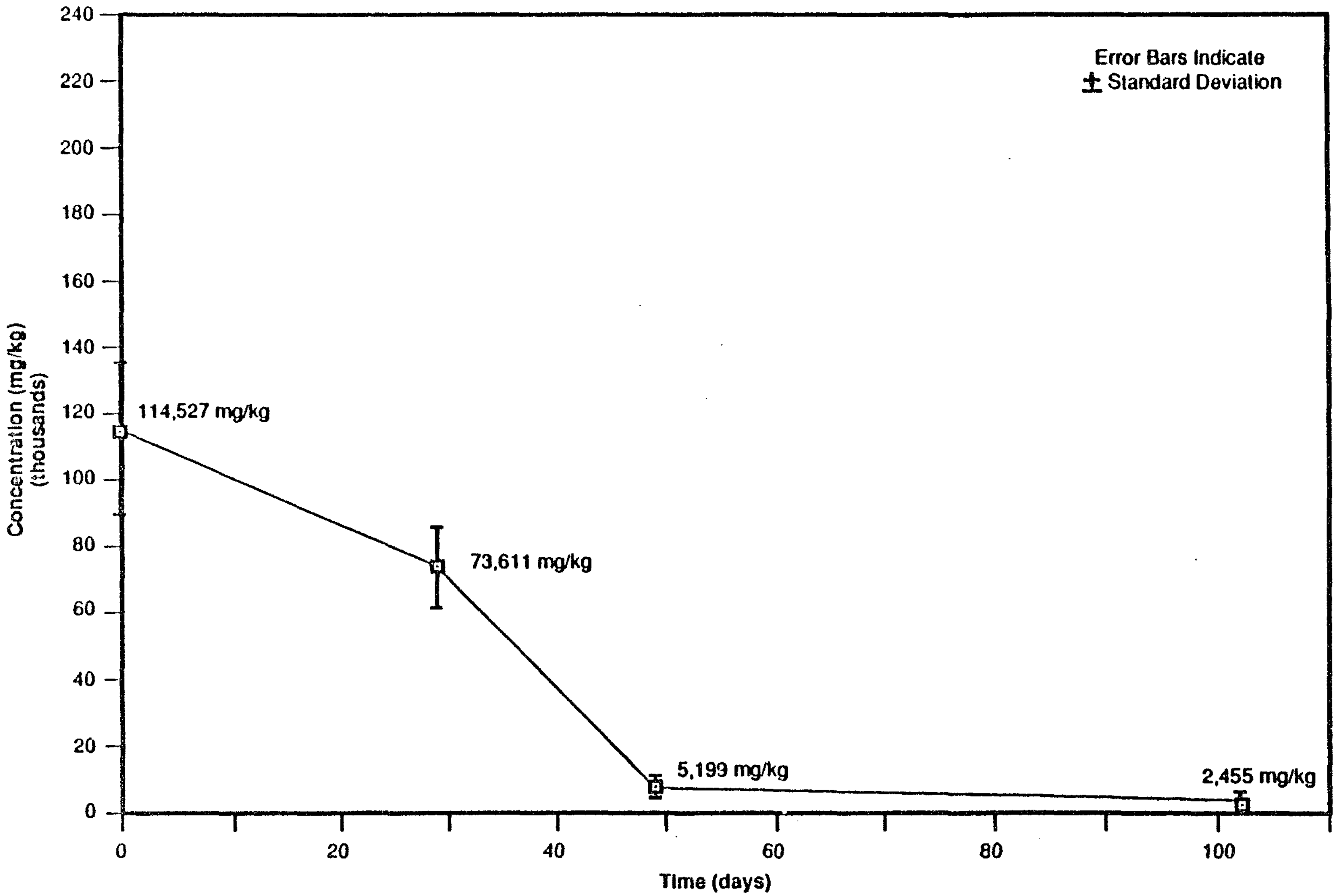
121-513A

Figure 5-8. Concentration of nitrocellulose in bagged compost - pile 3 - 5%



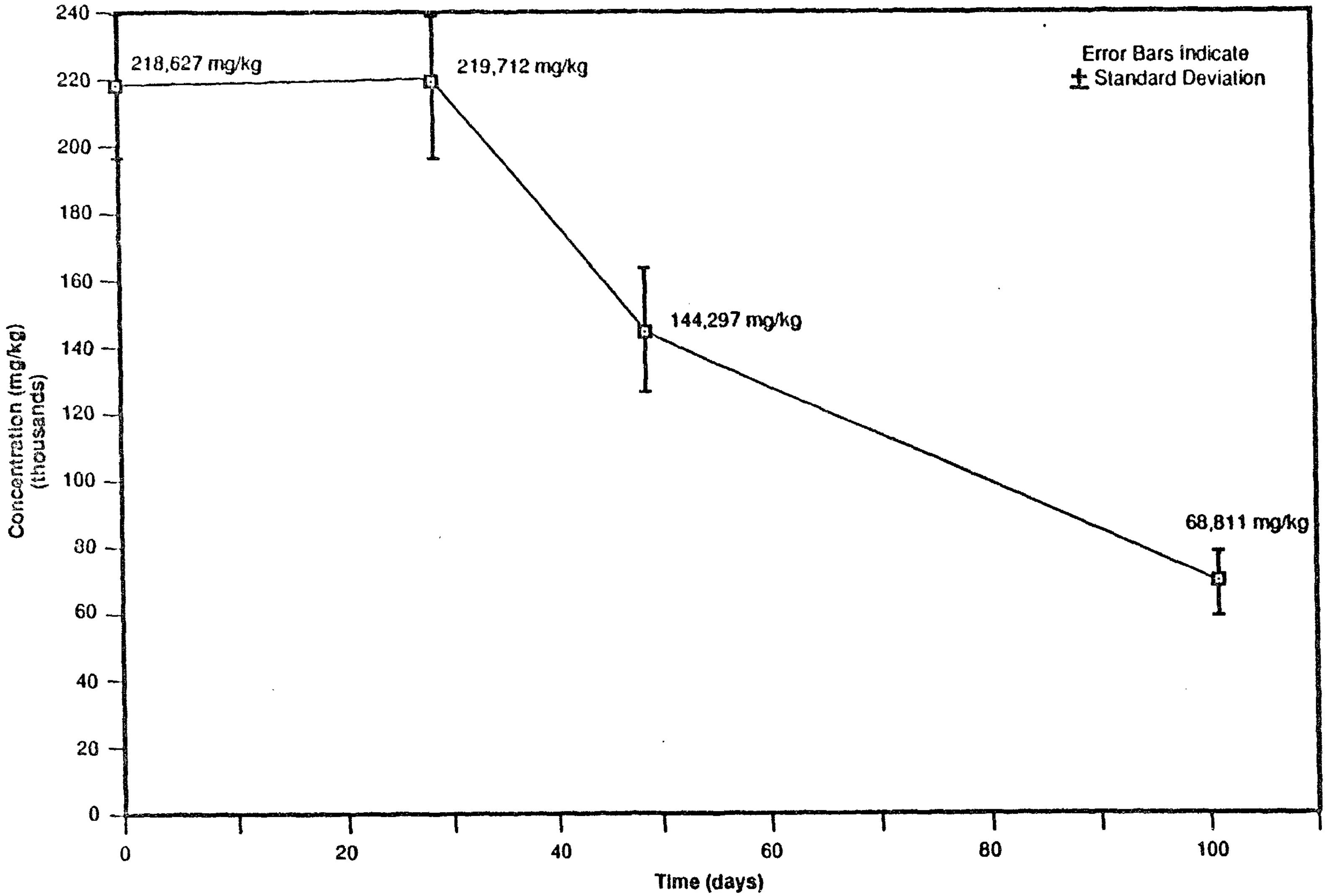
121-513B

Figure 5-9. Concentration of nitrocellulose in bagged compost - Pile 3 - 15%.



121-513C

Figure 5-10. Concentration of nitrocellulose in bagged compost - Pile 3 - 30%.



121-513D

Figure 5-11. Concentration of nitrocellulose in bagged compost - Pile 3 - 60%.

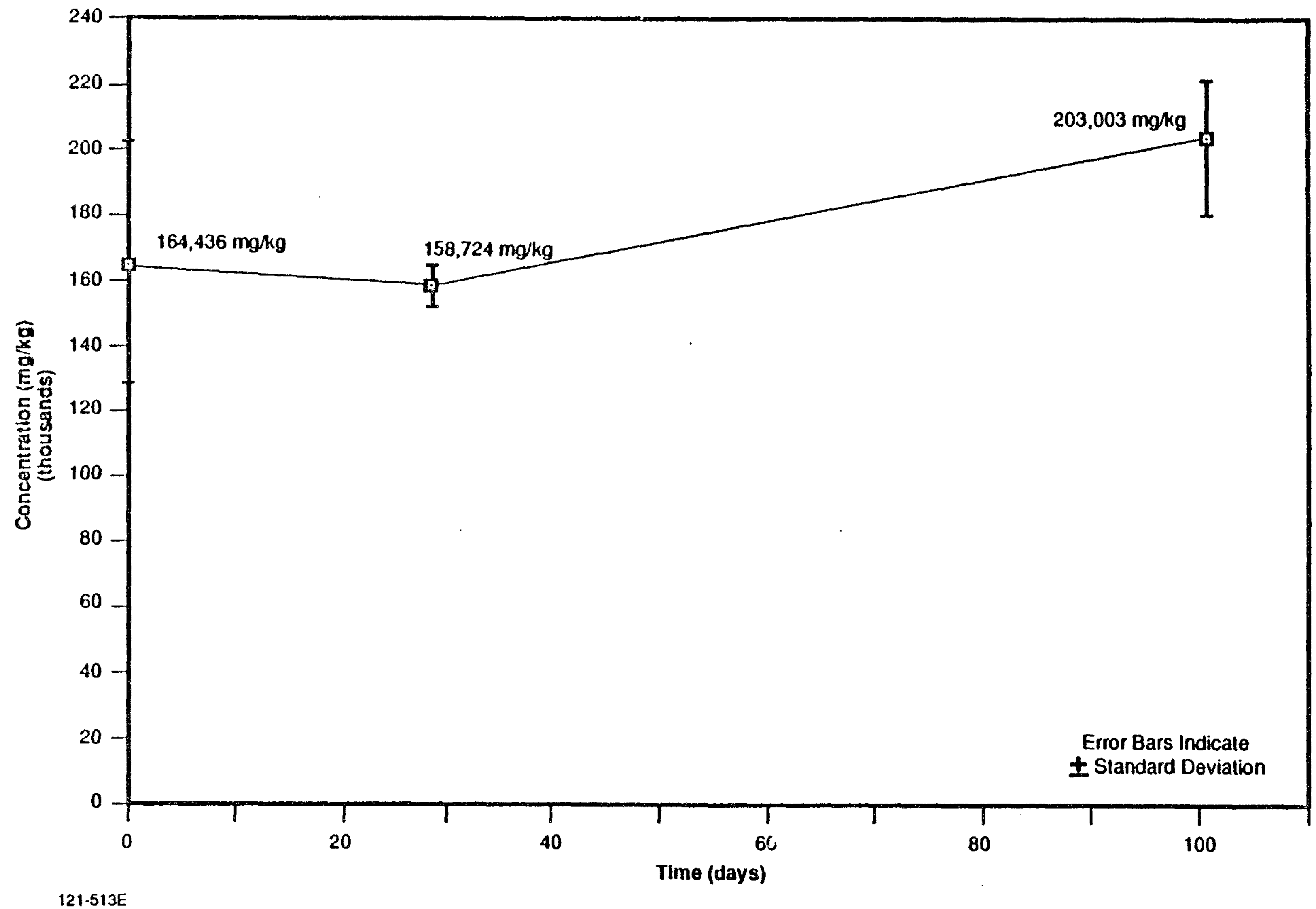


Figure 5-12. Concentration of nitrocellulose in bagged compost - Pile 3 - 80%.

was observed through day 29 in the 80-percent samples; the slight increase in NC levels at day 101 is believed to be a result of problems in the extraction process.

NC was not detected in the sump at week two.

5.2.5 Nonquantitative Observations

Heavy fungal growth was observed in the outer 4 inches of pile 4, particularly in the regions farthest from the blowers. The compost covered with the fungal mycelium was distinguished by its light gray color; tough, fibrous texture; and drier composition than the surrounding material.

The significantly settled piles, particularly pile 3, had hardened by week 14 of the test period. The compost in pile 3 was dry and extremely hardened, and by the end of the test period was completely frozen.

The compost in pile 4 became noticeably more homogeneous in appearance by week 14 of the test period.

5.3 DISCUSSION

5.3.1 Fate of Nitrocellulose in Compost Piles 3 and 4

The concentrations of nitrocellulose were significantly reduced during the 112-day test period of compost piles 3 and 4 (see Figures 5-6 and 5-7). Both piles exhibited greater than 99.5 percent reduction in NC from time-zero; this is particularly encouraging in light of the fact that the initial soil loading was increased from the 19 percent utilized in piles 1 and 2 to 22 percent in pile 3 and 32.5 percent in pile 4. Equally encouraging are the results from the NC-spiked bag experiments (see Figures 5-8 through 5-12). The contaminant levels were significantly reduced from levels as high as 60-percent NC by weight, with little or no destruction observed in only the 80-percent NC-spiked samples. The final concentration of NC in these bags at the end of the study was still relatively high. However, there appears to be no inherent reason why these levels could not be taken to the same low levels observed in the bulk mixture using the composting process.

5.3.2 Temperature/Aeration Control and Monitoring

As can be seen in the plots of daily temperature in piles 3 and 4 (Figures 5-2 through 5-4), the temperature in pile 3 decreased quickly after day 75. This temperature drop was a function of two factors: the porosity in the pile was greatly diminished as a result of settling; and the ambient air temperature had substantially decreased (see Figure 5-1). The temperature in pile 4 also decreased, but leveled out in the mesophilic C temperature range. However, as shown in Figures 5-5 and 5-6, the majority of the NC degradation occurred within the first 30 days of the project.

Decreased air flow as a result of settling was not as much of a problem in piles 3 and 4 as in piles 1 and 2. This was most likely due to the addition of wood chips in the initial compost matrix, which increased the porosity of the pile and allowed more efficient aeration.

As in Phase I, the top portions of piles 3 and 4 were generally warmer than the lower regions.

5.3.3 Compost Moisture and Remixing

Periodic moistening of the compost was required to maintain an appropriate (above 40 to 45 percent) moisture content for the microbial populations. One remixing was undertaken during the test period to accomplish this. However, regular (two to three times per week for approximately 2 hours) watering of the piles using a hose was halted after day 50 because of the formation of ice on the insulative blanket.

5.3.4 Microbial Populations

The data obtained from the microbial enumerations suggest several trends (see Table 5-6). Both piles contained viable populations of thermophilic organisms capable of growth at 55°C. The number of both colony forming units/gram and the number of morphologies/gram increased over time in both piles.

SECTION 6

CONCLUSIONS AND RECOMMENDATIONS

The results of this field demonstration indicate that composting is a feasible technology for reducing the extractable nitrocellulose concentration in contaminated soils. In addition, this field demonstration provides tentative evidence indicating that NC can be degraded when incorporated into a mixture to be composted at a high concentration. This indicates that composting may be appropriate for the disposal of NC fines.

The data obtained in the "bag" experiments indicate that NC fines can be degraded if incorporated into a mixture to be composted at a level much higher than the 3,000 to 13,000 mg/kg present in the Phase I and Phase II piles. Destruction of NC was observed within small quantities of compost specially prepared to contain (by weight) approximately 3, 5, 7.5, 10, 15, 30, and 60 percent NC. However, these small bags were placed in a mixture generally containing less than 1 percent NC and which composted effectively. Although it appears that NC can be degraded at concentrations as high as 60 percent, it has not been established that a large quantity (several cubic yards or more) of a mixture to be composted which contains these high NC concentrations will compost effectively. Investigating this issue should be the focus of an ongoing research and development effort. The data obtained would be applicable to existing problems at both the BAAP and Radford AAP.

In the bags prepared to contain 10 percent NC and placed in pile 2, NC was reduced from 23,600 mg/kg to 97 mg/kg. In the bags prepared to contain 30 percent NC and placed in pile 3, NC was reduced from 114,527 mg/kg to 2,455 mg/kg at the end of the test period. During the investigation NC concentrations in the 2,500 mg/kg range were demonstrated to be reducible to below 50 mg/kg. Therefore, it is likely that with additional time and/or manipulation, a compost mixture starting at 114.527 mg/kg or higher could also be reduced to below 50 mg/kg.

The separation of mesophilic and thermophilic temperature ranges in Phase I was not as satisfactory as that achieved in the Louisiana Army Ammunition Plant (LAAP) field demonstration (Williams et al., 1988). This was primarily due to the consistency of the horse manure/straw used at LAAP compared to the cow manure used at BAAP. Although not quantified. the BAAP mixture appeared to be much less porous than the LAAP mixture. Cow manure, while effective for achieving composting, is difficult to work with in that it becomes crusty upon drying, thereby further decreasing porosity.

This lower porosity at BAAP reduced the ability of the aeration system to maintain the mesophilic temperature range. Significantly more air flow is required to maintain 35° than 55°C. However, the data obtained in Phase I at BAAP suggest that thermophilic temperatures were more conducive to rapid NC destruction than mesophilic temperatures. Consequently, thermophilic conditions were sought for both piles in Phase II.

Effective composting was achieved at all soil loading rates tested (19, 22, and 32.5 weight percent). During Phase II, the 32.5-percent soil pile maintained temperature for a longer period of time than the 22-percent soil pile. Consequently, soil loading rates at least as high as 32.5 percent should be usable if full-scale implementation is undertaken.

Successful composting will likely occur at sediment loading rates up to, or possibly exceeding, 50 weight percent (provided that parameters such as moisture and contaminant concentration are within favorable ranges). Maximizing the proportion of sediment or soil in mixtures to be composted will enhance the economic feasibility of the treatment process by minimizing bulking agent/carbon source usage, as well as treatment time for a given site. The quality of the organic carbon required to prepare the mixture to be composted and to facilitate degradation of the contaminants should also be investigated since this will directly affect costs.

Effective composting at BAAP was initiated and maintained under harsh climatic conditions. These conditions included abnormally hot and dry summer weather. This performance demonstrates the resilience of the composting process to ambient weather conditions.

The use of wood chips, sawdust, or other materials to form a base and insulating cover for compost piles should be discontinued. A portion of this material inevitably becomes incorporated into the compost during remixing. Thus, previously uncontaminated and generally nondegradable materials become contaminated and increase the volume of waste to be treated.

Concrete composting pads with aeration pipes located below grade would eliminate the need for wood chip bases and would also reduce short-circuiting of air through the base material. A form-fitting cover of fiberglass or other suitable insulation would provide an inert, air-permeable, insulative blanket for compost piles. This type of cover could be used repeatedly. Short-circuiting of air in the compost matrix almost certainly occurred during the present study.

Designing the shape of and supporting structure for a compost pile to force air to flow through the compost in one direction only would minimize short-circuiting. An enclosed vessel or bin with an aeration pipe below the bottom of the mixture to be composted and an open top would likely resolve this problem.

Triangular-shaped (cross-section) static piles are probably not ideal for a full-scale treatment process, although they served well to demonstrate proof of concept in the present study. Actual site remediation or NC fine disposal calls for a composting system capable of handling a relatively continuous influx of material to be decontaminated. A series of four or more vessels or bins as described previously would allow composts of increasing age to be in process and moved, mixed, and moistened periodically, as well as allow for semicontinuous loading of incoming wastes.

The compost piles constructed at BAAP tended to dry out rapidly, creating less than optimal conditions for microbial metabolism and contaminant destruction. Saturating all air entering the compost piles with water vapor may be a useful addition to the treatment process. Alternatively, liquid-phase water could be continuously or semicontinuously applied to compost piles, but it could cause leachate production and may not be evenly distributed. The compost mixture should be periodically mixed to achieve good surface contact. Water can be added relatively easily at these remixing time points.

Developing a mixing system suitable for processing propellant and/or propellant-contaminated soil is a requirement. The system must achieve good homogeneity, handle materials with high bulk densities such as soils, and meet all safety criteria.

An improved, automated temperature control and monitoring system is required. An improved system would consist of at least six thermocouple probes placed in each compost pile and a microcomputer-based monitoring/control system to regulate the operation of the blower(s). At the basic level of operation, temperatures measured by the thermocouples would be averaged by the computer, and this average temperature would be used to control the cycling of the blowers. Enhancements could include differential aeration to discrete areas within the pile in response to temperature and moisture conditions, as well as automatic recording and plotting of compost temperatures using a spreadsheet software program.

Acceptable methods for disposal of the final compost residue should be evaluated. For example, criteria for disposal by land application should be established by working with the appropriate regulatory authority.

In conclusion, the present study demonstrated extensive reduction of solvent-extractable NC in compost after approximately 4 months of field-scale treatment. The exact fate of the NC could not be determined, but microbial degradation is likely the major fate processes. Refinements in the materials balance for the material to be composted, process control strategy, and materials handling will serve to further optimize process and cost efficiencies.

SECTION 7

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APPENDIX A

USATHAMA ANALYTICAL METHOD LY02

5730B

NITROCELLULOSE IN SOIL

I. SUMMARY

A. Analyte: Nitrocellulose (NC)

B. Matrix: Soil, Sediment, or Compost.

C. General Method: A solid sample is extracted with acetone using ultrasonic agitation. A portion of the extract is dried and washed with a methanol/water solution to remove endogenous nitrate and nitrite salts. The washed sample is then dissolved in acetone and hydrolyzed by treatment with aqueous potassium hydroxide at an elevated temperature. Nitrite ion is cleaved from the nitrite ester which diazotizes procaine, in acid solution, which in turn reacts with N,N-dimethyl-1-napthylamine producing a dye with a maximum absorbance at 510 nm.

II. APPLICATION

A. Calibration Range: 250 - 50,000 ug/L.

B. Sensitivity: Not applicable.

C. Reporting Limit: 13.0 ug/g.

D. Interferences: This method could be subject to matrix interferences from the sample. Endogenous nitrate and nitrite should be completely removed in the extraction process. Other nitrate esters which liberate nitrite under the conditions used for hydrolysis cannot be distinguished from each other.

E. Analysis rate: Ten (10) samples can be extracted and analyzed in an eight hour day.

F. Safety Information: Nitrocellulose is a flammable solid and acetone is a flammable liquid. Open flames and sparks should be avoided at all times.

General laboratory safety procedures should be observed when handling nitrocellulose (e.g. gloves, lab coats, and eyewear).

APPARATUS AND CHEMICALS

A. Glassware/Hardware:

1. Volumetric Flasks: 100 mL, 250 mL, 1 liter.
2. Class A Pipettes: 1 mL, 2 mL, 5 mL, 10 mL.
3. Eppendorf pipettes.
4. Hot plate.
5. 500 mL conical centrifuge tubes.
6. 10 mL glass vials.
7. Sonic bath.
8. Balance.
9. Beakers: 500 mL.
10. Whatman No. 42 ashless filter paper.
11. Funnels.

B. Instrumentation: Perkin-Elmer Lambda 3 Dual Beam UV/VIS Spectrophotometer

C. Analytes: Nitrocellulose

1. CAS Number: 9004-70-0
2. Physical Properties: Mp = 160°C (Ignites)
   Bp = Not Applicable

D. Reagents and Reference Materials (RM):

1. Nitrocellulose (Olin Chemicals): No Lot No. (documentation of characterization attached)
2. Phosphoric Acid (85%): Fisher Scientific (ACS Grade).
3. N,N-Dimethyl-1-naphthylamine. Kodak (Reagent Grade).
4. Procaine (99%) Aldrich Lot # 1523BK.
5. Potassium Hydroxide (KOH) (2N): Fisher Scientific (Reagent Grade).
6. Acetone: American Burdick and Jackson (High Purity ACS Grade).

7. Acetic Acid (10%): Fisher Scientific. (Reagent Grade).

8. Nitrogen Gas. (Prepurified).

9. Methanol: American Burdick and Jackson (High purity ACS Grade).

IV. CALIBRATION

A. Initial Calibration.

1. Preparation of Standards:

a. A stock nitrocellulose calibration standard is prepared by quantitatively transferring 1,250 mg of dried nitrocellulose into a one liter volumetric flask and diluting to the mark with acetone. The resulting stock solution contains 1,250 mg/L NC.

b. An intermediate calibration standard is prepared by diluting 10 mL of the stock standard to 100 mL in a volumetric flask.

c. Working calibration standards are prepared daily by diluting the stock standard according to the following schedule in 250 mL volumetric flasks (prepare two sets for precertification):

STANDARD	CONCENTRATION UG/L - NC	mL OF INTERMEDIATE TO ADD PER 250 ML	mL OF STOCI PER 250 ML
BLANK	0	0	----
0.5X	250	0.5	----
X	500	1.0	----
2X	1000	2.0	----
5X	2500	5.0	----
10X	5000	10.0	----
20X	10,000	----	2.0
50X	25,000	----	5.0
100X	50,000	----	10.0

2. Instrument Calibration.

   a. Set up instrument according to manufacturer's recommendations.

   b. Proceed with steps 1 through 12 in Section VIII.

   c. Analyze the calibration standards.

   d. Analyze a calibration check standard as in Section IV.1.A. This standard is prepared by a second analyst on a separate balance using different pipettes. This is prepared in the same manner as the calibration standard except 1150 mg of NC is dissolved in 1 liter of acetone, instead of 1250 mg. 5 mL of this stock is diluted to 250 mL final sample volume giving a final NC concentration of 23,000 ug/L.

   e. A second 50,000 ug/L working calibration standard is analyzed after completion of sample analysis.

3. Analysis of Calibration Data:

   a. Tabulate and plot the calibration standard concentration versus response (absorbance units) for each calibration standard. Data are then subjected to USATHAMA LOF test for linearity and ZI test to determine if the curve passes through the origin of a cartesian x-y plot.

B. Daily Calibration

   1. Initial calibration will be performed daily, as per section IV.A.

V. CERTIFICATION TESTING

A. Preparation of Certification Samples.

   1. Utilize the same stock solution and intermediate solution as described in section IV.A.1.

   2. In a series of conical centrifuge tubes, place 10g of USATHAMA standard soil.

3. The soil samples are then spiked according to the following schedule with the stock solutions prepared above:

SAMPLE	mL OF STOCK 1250 mg NC/L	mL OF INTERMEDIATE 125 mg NC/L	TARGET UG/G
BLANK	0	0	0
0.5X	----	0.5	6.25
X	----	1.0	12.5
2X	----	2.0	25.0
5X	----	5.0	62.5
10X	----	10.0	125
20X	2.0	----	250
50X	5.0	----	625
100X	10.0	----	1250

4. Allow the spiked soil samples to sit for at least one hour before processing.

5. Extract and analyze according to Section VII.

VI. SAMPLE HANDLING AND STORAGE

A. Sampling procedure: Normal precautions should be taken to avoid contamination of the sample from external sources.

B. Containers: Amber glass bottles with teflon-lined lids are acceptable.

C. Storage Conditions: Cool to 4°C.

D. Holding time limits: 7 days from time of sampling.

E. Solution verification: Section IV.A.2.d.

VII. PROCEDURE

A. Preparation of Nitrocellulose Reference Material:

1. Dry a portion of as-received NC under a gentle stream of nitrogen. Place this nitrogen dried material in a convection oven at 105°C until a constant weight is obtained.

2. Weigh 1,250 mg of dried NC and quantitatively transfer to a one liter volumetric flask with small portions of acetone. Dilute to the mark with acetone for a final NC concentration of 1250 mg/L.

B. Extraction:

1. Weigh 10g of as received sample or standard soil into a clean, dry conical centrifuge tube.

2. Extract with 125 mL of acetone by placing in an ultrasonic bath for 30 minutes.

3. Filter the mixture using Whatman 42 ashless paper. The filtrate is saved.

4. Repeat steps 2 and 3 one time, and combine with filtrates in a 250 mL volumetric flask (do not dilute to 250 mL).

5. Transfer 1 mL of the diluted filtrate to a glass vial. Evaporate to dryness under gentle stream of nitrogen at ambient temperature.

6. Wash the residue with 2 mL of a 90:10 methanol:water mixture to remove endogenous nitrate and nitrite.

7. Decant the methanol/water wash and discard.

8. Add 1 mL of acetone and 1 mL of 2N potassium hydroxide and 1 mL of water to the sample.

9. This mixture is placed in a hot water bath maintained at 100°C, and hydrolyzed for 30 minutes.

10. Following hydrolysis (step 9) the sample is acidified with 4 mL of 10% acetic acid.

11. The color reagent is prepared by dissolving 0.35 g each of procaine and N,N-dimethyl-1-napthylamine in 50% acetic acid in a 100 mL volumetric flask, and diluting to volume with additional 50% acetic acid.

12. Add 1 mL of color reagent. Allow color to de'elop for 90 minutes. After color development, analyze as in Section IV.2.

B. Chemical Reactions

Nitrocellulose is solubilized in acetone during the extraction process. Endogenous nitrate and nitrite are removed from the dried acetone extract by washing with aqueous methanol. Finally, nitrocellulose is hydrolyzed to cellulose and nitrite by the action of aqueous potassium hydroxide at 100°C. Nitrite ion is cleaved from the nitrite ester which diazotizes procaine, in acid solution, which in turn reacts with N,N-dimethyl-1-napthylamine producing a dye with a maximum absorbance at 510 nm.

C. Instrumental Analysis

1. Calibrate the instrument as outlined in Section IV.

2. Analyze a calibration check standard.

3. Analyze samples.

4. Analyze a calibration check standard.

VIII. CALCULATIONS

A. Calibration data are entered into a calculator or computer program for least squares regression using the responses as Y values and target concentrations as X values. The program will calculate an equation to describe the data. The general form of the equation is

$$Y = aX + b$$

where Y = response
X = true concentration
a = slope of the regression line
b = Y intercept (X = 0)

B. Concentrations in samples are derived from the least squares regression of the calibration data. Values of a and b are obtained from the computer regression calculations.

C. The equation in VI.A is rearranged to yield

$$X = (Y - b)/a$$

By substituting the sample response (Y) into this equation, the extract concentration may be obtained. Many computer regression programs have this function as an inherent capability.

D. The concentration in the original matrix is calculated from

$$\text{Concentration of NC in Original Matrix (ug/g)} = \frac{X \text{ *Extract Volume (L)}}{\text{Wt of Sediment (g)*Fraction solids}}$$

where X is in terms of ug/L NC.

IX. DAILY QUALITY CONTROL

A. Control Samples:

1. Daily control samples are prepared in the same manner as certification samples described in Section V. A total of three control spikes are required on a daily basis: two at approximately 10x the CRL and one at approximately 2x the CRL.

2. At least one method blank using USATHAMA Standard Soil carried through the digestion procedure is also analyzed with each analytical lot.

B. Control Charts:

1. Average Percent Recovery (X)

a. The initial control chart shall be prepared using the four days of certification data closest to the spiking concentration used during analysis.

b. Values for the highest concentration from the certification data will be averaged to determine the central line of the control chart (X).

c. Differences in percent recoveries for each pair of values are averaged to obtain the range (R).

d. The upper and lower warning limits are +/- 1.25R from the central line.

e. The upper and lower control limits are +/- 1.88R from the central line.

f. Results from the highest standard spikes analyzed during analysis will be averaged to update the average X(X), and average range (R) after each lot and which in turn will be used to update control limits for X and R after each lot for the first 20 lots.

g. Limits established after lot 20 shall be used for the next 20 lots.

2. Difference in Percent Recoveries (R)

   a. The value for R obtained in Section VIII.B.1.C, above, is the base line of the control chart.

   b. The warning limit is 2.511 R.

   c. The control limit is 3.267 R.

3. Three-point Moving Average X:

   a. The average percent recovery from the 2X concentration from the first three days of certification testing is the first point to be plotted.

   b. Subsequent points to be plotted are the average percent recoveries from the 2X concentration from the next group of three determinations.

   c. The central point on the control chart is the average of the plotted points and changes with each added point.

   d. The range for each point is the difference between the highest and lowest values in each group of three determinations. The average range (MAR) is used to define the warning control limits.

   e. The upper and lower warning limits are +/- 0.682 MAR, respectively.

   f. The upper and lower control limits are +/- 1.023 MAR respectively.

4. Three Point Moving Average R:

   a. The baseline is the MAR.

   b. The warning limit is 2.050 MAR.

   c. The control limit is 2.565 MAR.

X. REFERENCES

A. Determination of Nitrocellulose in compost. ARC Nitrocellulose composting Task. Technical Report.

B. Method 3H. Determination of Nitrocellulose, Nitroglycerine, and PETN in water.

XI. DATA

A. Off-the-shelf Analytical Reference Materials Characterization:

   See attached.

B. Initial Calibration.

   1. Response versus concentration data: see attached.

   2. Response versus concentrated graphs: see attached.

C. Daily Calibration.

   1. Not applicable.

D. Standard Certification Samples.

   1. Tabulation and graph of found versus target concentration:

      See Attached.

   2. LOF and ZI tests for the pooled data:

      See Attached.

   3. Calculated least squares between regression line confidence bounds, reporting limit, accuracy, standard deviation percent imprecision, and percent inaccuracy:

      See Attached.

IX. CALIBRATION CHECK STANDARD RECOVERIES

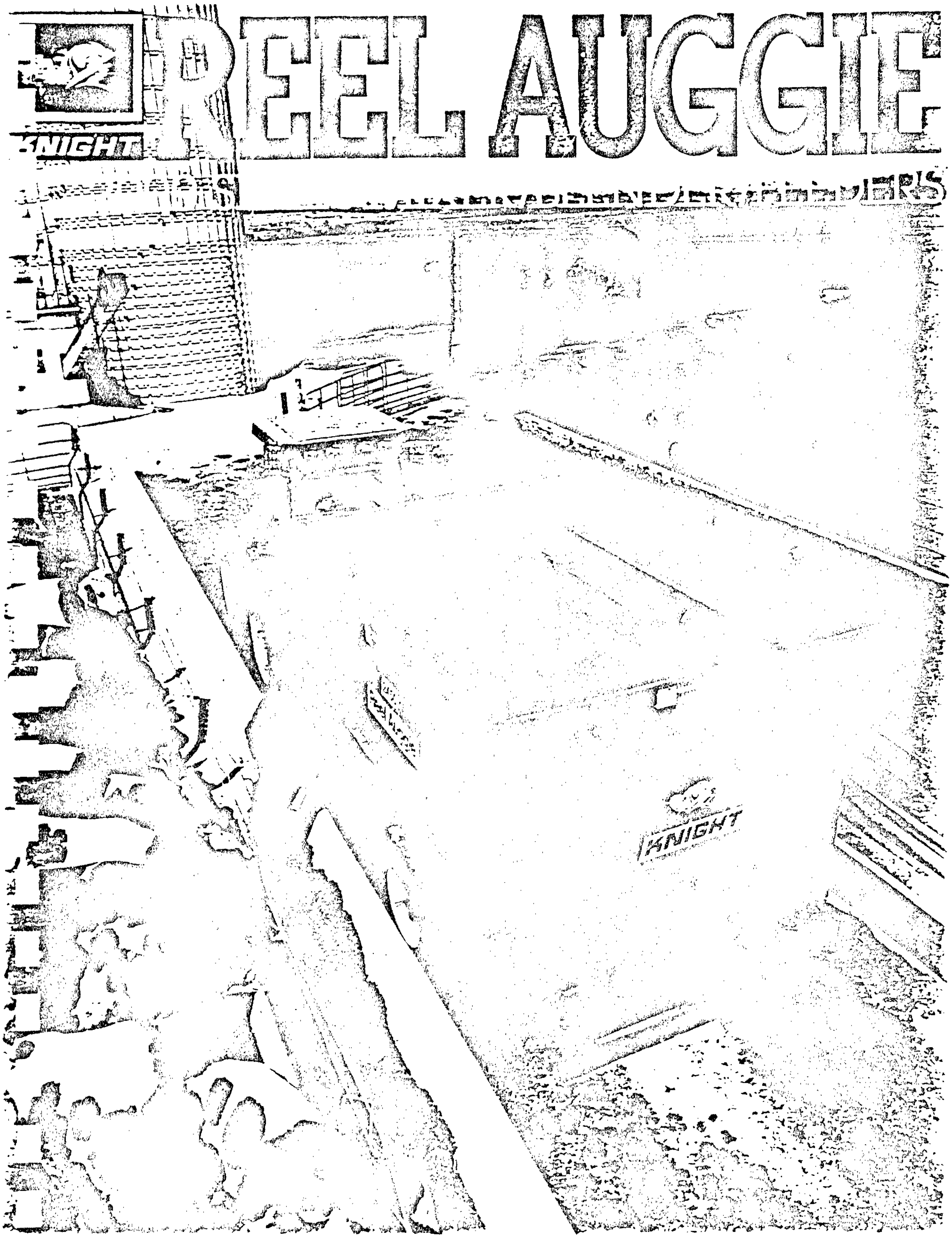
A. See Attached.

APPENDIX B

KNIGHT REEL AUGGIE MIXER SPECIFICATIONS

5730B

REEL AUGGIE



Knight 2000 Series Reel Auggies . . . A new concept in Mixer/Blender/Feeders.

Knight Manufacturing Corporation pioneered the 3-auger type of feed mixer in the midwestern and eastern livestock areas. Since 1965, the 3-auger type mixer has been the "top-of-the-line" in feed mixing equipment. After more than four years of exhaustive engineering, development, and field testing, we proudly introduce the "Reel Auggie" - a new concept in feed mixers. The extensive field testing program included active participation by many livestock farmers, each of which were previous owners of various types of mixers. These farmers share a new enthusiasm and confidence for the Reel Auggies.

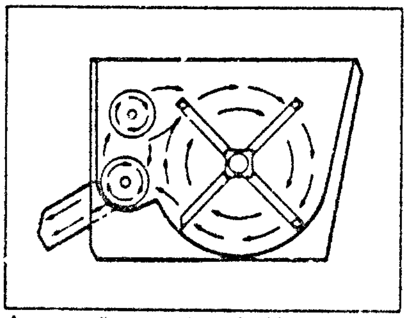
Just what makes the "Reel Auggie" better?

1. You can finally mix and feed all of your ration ingredients including long stem dry hay and other tough roughages that previously could not be included in your mixed ration. Standard square bales, stacked hay, and processed round bales can be added directly to the load. Veterinarians agree that longer dry hay in the ration helps activate the rumen for improved digestion. Better milk production, better weight gains, and vastly improved animal health are just some of the positive results. Now you can control the percentage of dry hay in your ration and know that each animal will get its share.
2. No more mixing by force and pressure, which causes compressed and crushed materials and possible breakdown of material fiber. The "Reel Auggie" blends by gently lifting, fluffing and tumbling the ration - leaving the ration in a more palatable and "whole" state than other mixers. Farmers agree that rations are blended faster, power requirements are lower, machine life is extended, and that the final mixed ration is of a higher quality than previously attainable

The Reel Auggie design helps make important cost savings possible by blending such inexpensive by-products as cotton seed, wheat mids, brewers grains and sweet corn silage. Some feeders are also using waste potatoes, bakery waste, liquid animal fat, even candy bars and other human food by-products. The Reel design effectively handles fine grains, liquid supplements & mineral additives.

The "Reel" Mixing Chamber.

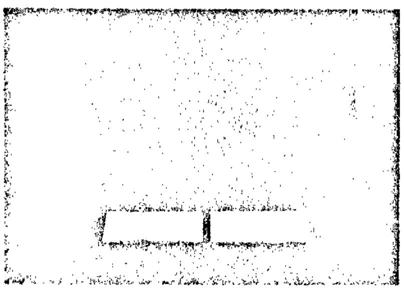
The large diameter Reel turns slowly, gently lifting all materials up and into the blending augers. The lower notched auger turns at a medium speed and moves the ration toward the front of the unit. The lower auger also brings the mixed ration to the door opening during the unloading process. The upper auger turns at a higher speed, and incorporates replaceable hardened knives that assist in blending and cutting the long stem hay and moving material toward the rear of the unit. The combination of these three components is the secret of the fluffier more palatable ration.



A cross section view shows the lifting action of the Reel

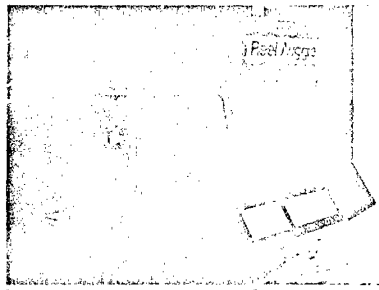
A Choice of Discharge Options

The Reel Auggie discharge door is higher off the ground than traditional 3 and 4 auger mixers. In most applications this will allow the use of a simple hydraulically controlled slide tray.



The slide tray offers simple operation with less moving parts

Knight has designed a new 3-auger hydraulically driven Power Chute for those applications that cannot utilize the slide tray. The Power Chute features three 9 inch diameter augers with replaceable polyethylene liners

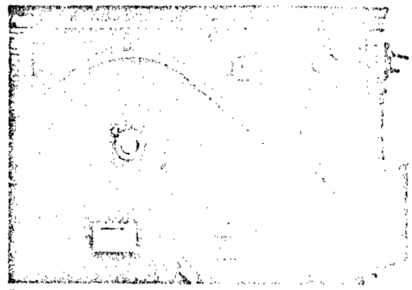


The new three auger Power Chute provides versatility in unloading.

Oil-Bath Drive Enclosure

The rugged front drive is enclosed in a dust-free oil bath environment. It features a simple chain and sprocket drive, sealed greasable bearings, and spring loaded tension idlers.

The final drive shafts and sprockets are splined for added strength and reliability.

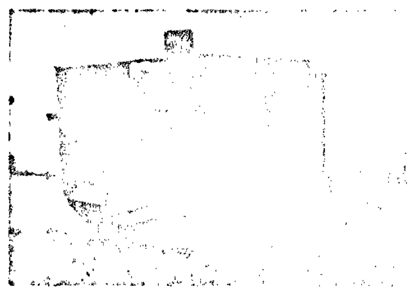


The front drive components are enclosed in an oil bath environment.

Tow, Truck, or Stationary Units.

All of the Knight Reel Auggies are available for stationary applications, and all except the smallest RA2120 are available in tow-type or truck mounted units.

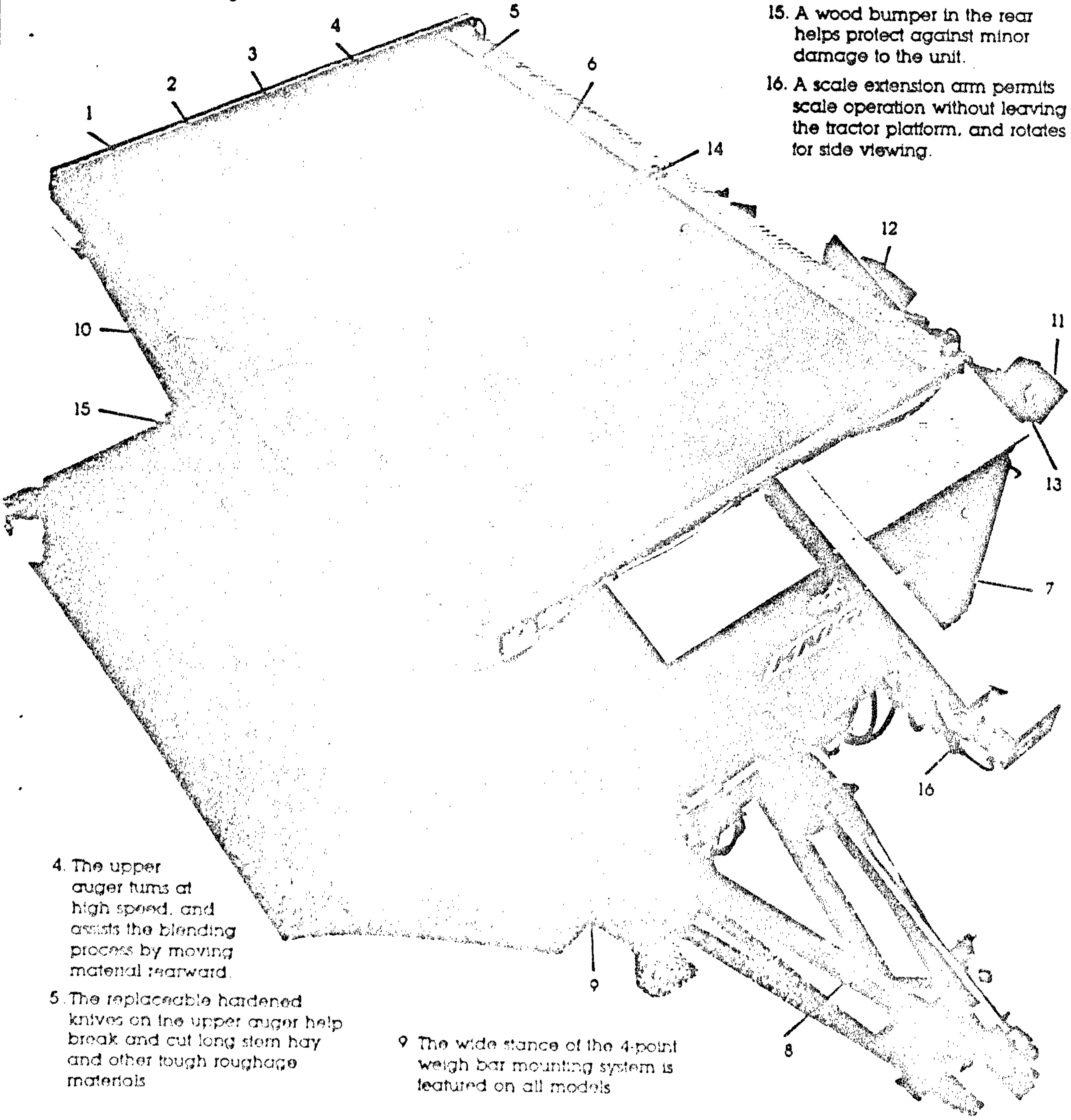
The larger size Reel Auggies are available truck mounted



All models are available for stationary applications

Design Features of the Reel Auggie.

1. The rugged Reel "spider" weldment is designed for durability and long service life.
2. The spring loaded Reel crossbars minimize binding and wedging, and help reduce power requirements.
3. The spring loaded polyethylene "wipers" assist in blending even the finest ingredients as well as assuring a fast efficient clean-out when unloading.
4. The upper auger turns at high speed, and assists the blending process by moving material rearward.
5. The replaceable hardened knives on the upper auger help break and cut long stem hay and other tough roughage materials.
6. The notched lower blending auger moves material forward while mixing. It also functions as the discharge auger, providing a fast, even flow of materials to the discharge door.
7. The front drive enclosure provides a dust-free oil bath environment for the chain and sprocket drive.
8. The rugged single axle undercarriages feature rectangular tube construction with an adjustable height clevis hitch.
9. The wide stance of the 4-point weigh bar mounting system is featured on all models.
10. Drain plugs are provided at the bottom of each hopper.
11. Large, powerful magnets are standard on all Slide Trays and Power Chutes.
12. The hydraulically operated discharge door controls the unloading rate.
13. Choice of discharge options includes Tray or Power Chute.
14. A bucket guard helps prevent an endloader bucket from contacting the Reel arms.
15. A wood bumper in the rear helps protect against minor damage to the unit.
16. A scale extension arm permits scale operation without leaving the tractor platform, and rotates for side viewing.

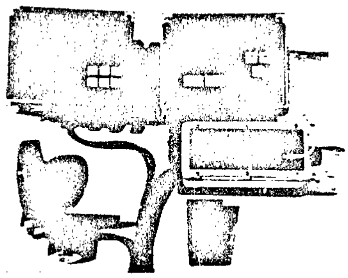


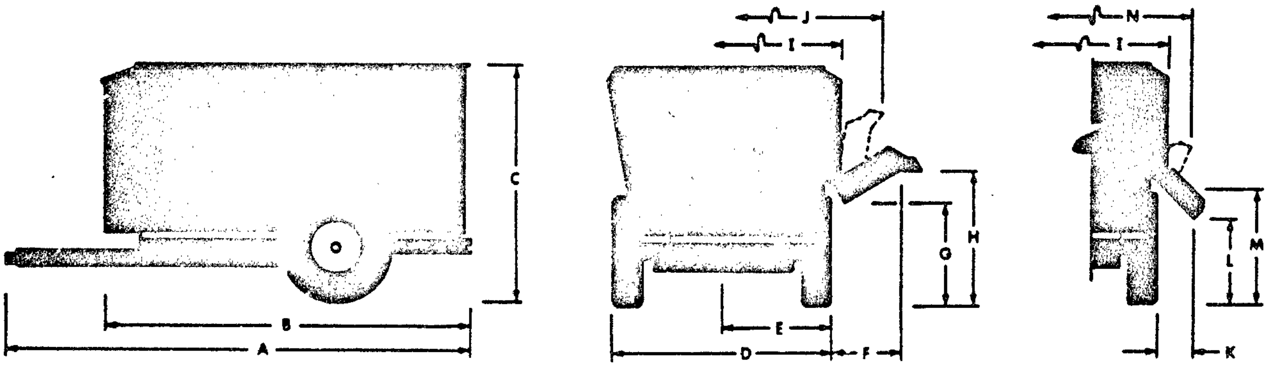
Electronic Scales for Accurate Rations.

Two electronic digital scale systems are available using strain gauge type weigh bars and 3/4" LCD displays, and both are accurate to within one percent.

The Model 630 system uses a horn and light alarm to signal when an operator's pre-determined weight has been attained.

The model 625 is a direct read-out system that does not use an alarm. A radio control unit is available for the model 625 to zero the unit from a remote location. An additional 1" digital display is available for either model to allow the operator to read weights from a remote location. All systems are complete, less the 12 volt battery required for mobile units.





Model	2120	2250	2375	2450
A - OA Length	–	188	192	216
B	91	136	142	166
C - OA Height	60½	84	102	102
D - Tread Width	–	82	94	94
E	–	41	47	47
F - (Min.-Max.)	–	34½-36	39½-41	39½-41
G	–	26	38	38
H (Min.-Max.)	–	21-47	33-59	33-59
I - OA Width	79½	88	101½	101½
J - Transport Width	–	112	125½	125½
K - (Min.-Max.)	–	13-19	18-24	18-24
L - (Min.-Max.)	15	19-26	31-38	31-38
M	–	32	44	44
N - Transport Width	–	98½	112	112
Cubic Ft. Struck Capacity	120	250	375	450
Cubic Ft. Mixing Capacity	105	216	325	390
Bushel Mixing Capacity	84	173	260	312
Approx. Weight (lbs. Tow)	2200	5240	7400	8190
Reel Diameter	52"	52"	68"	68"
Lower Auger Diameter	16"	16"	20"	20"
Upper Auger Diameter	14"	14"	18"	18"
Auger Hopper (Thickness)	1/4"	1/4"	5/16"	5/16"
Reel Hopper (Thickness)	3/16"	3/16"	1/4"	1/4"
Side Sheets (Thickness)	12 GA.	10 GA.	10 GA.	10 GA.
End Sheets (Thickness)	10 GA.	10 GA.	7 GA.	7 GA.
Door Width Tow/Trk	NA	36"	36"	36"
Door Width Stationary	20"	20"		
Electric Drive	7½ HP	15 HP		
Roller Chains	50-60-80	60-80-100	80-100-120	80-100-120
Magnet	STD	STD	STD	STD
Power Chute	NA	STD	OPT	OPT
Slide Tray	NA	OPT	STD	STD

Specifications subject to change without notice

FEMA

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APPENDIX C

RAW DATA

5730B

Table C-1. BAAP Composting Project - Analytical Sample Log - Nitrocellulose, Pile #1

wk	Date	RFW ID#	Smpl#	ClientID	NC (mg/Kg)	Comments	mean NC (mg/Kg)	StDev
0	4/28/88	8805-261	5	wk0- 1 -1	1050		908	133
			6	wk0- 1 -2	815			
			7	wk0- 1 -3	1040			
			8	wk0- 1 -5	754			
			9	wk0- 1 -6	881			
3	5/18/88	8805-426	1	wk3- 1 -1p	3840		4523	648
			2	wk3- 1 -2p	5130			
			3	wk3- 1 -1c	4600			
6	6/8/88	8806-659	5	wk6- 1 -1c	3493		4933	1257
			6	wk6- 1 -1c-dup	3787			
			7	wk6- 1 -2p	5000			
			8	wk6- 1 -2p-dup	6838			
			9	wk6- 1 -2c	6006			
			10	wk6- 1 -2c-dup	7147			
			11	wk6- 1 -3p	5705			
			12	wk6- 1 -3p-dup	6656			
			13	wk6- 1 -3c	4743			
			14	wk6- 1 -3c-dup	3901			
			25	wk6- 1 -1-a	4143	samples with		
			26	wk6- 1 -1-b	3823	suffix a-e		
			27	wk6- 1 -1-c	4236	were taken		
			28	wk6- 1 -1-d	3311	after remix		
			29	wk6- 1 -1-e	5000			
8	6/22/88	8806-772	1	wk8- 1 -1c-a	1493	samples with	1722	959
			2	wk8- 1 -1c-b	1250	"b" suffix		
			3	wk8- 1 -2p-a	2407	are dups of		
			4	wk8- 1 -2p-b	2243	"a" samples		
			5	wk8- 1 -2c-a	86			
			6	wk8- 1 -2c-b	127			
			7	wk8- 1 -3p-a	2250			
			8	wk8- 1 -3p-b	2426			
			9	wk8- 1 -3c-a	2183			
			10	wk8- 1 -3c-b	2750			
10	7/6/88		3	wk10- 1 -1c	< 18		133	122
			4	wk10- 1 -2p	< 13			
			5	wk10- 1 -2c	19			
			6	wk10- 1 -3p	262			
			7	wk10- 1 -3c	117			
14	8/4/88	8808-229	9	wk14- 1 1c	183		323	313
			9	wk14- 1 dup	305			
			9	wk14- 1 hom	189			
			9	wk14- 1 hom dup	243			
			10	wk14- 1 2p	996			
			10	wk14- 1 dup	641			
			10	wk14- 1 hom	392			
			10	wk14- 1 hom dup	612			
			11	wk14- 1 2c	35			
			11	wk14- 1 dup	29			
			11	wk14- hom	56			
			11	wk14- hom dup	39			
			12	wk14- 3p	742			
			12	wk14- dup	713			
			12	wk14- hom	582			
			12	wk14- hom dup	631			
			13	wk14- 3c	31			
			13	wk14- dup	12			
			13	wk14- hom	25			
			13	wk14- hom dup	8			

GRAPH DATA

Time (days)	ave NC (mg/Kg)	ave+ stdev	ave - stdev
0	908	1041	775
20	4523	5172	3875
41	4933	6189	3676
55	1722	2681	762
70	133	255	10
98	323	637	10
151	651	651	651

Table C-1. BAAP Composting Project - Analytical Sample Log - Nitrocellulose, Pile #1 (cont.)

22	9/26/88	8809853	wk22 1	318	651	820
			wk22 2	27		
			wk22 3	37		
			wk22 4	1974		
			wk22 5	898		

Table C-2. BAAP Composting Project - Analytical Sample Log - Nitrocellulose - Pile #2

Wk	Date	RFW ID#	Smpl#	ClientID	NC (mg/Kg)	Comments	ave NC (mg/Kg)	StDev
0	4/28/88	8805-261	9	wk0- 2 -1	881		3039	4601
			10	wk0- 2 -2	1031			
			11	wk0- 2 -3	1130			
			12	wk0- 2 -5	11267			
			13	wk0- 2 -6	885			
3	3/18/88	8805-426	4	wk3- 2 -1p	302		1485	1714
			5	wk3- 2 -2p	3450			
			6	wk3- 2 -1c	703			
6	6/8/88	8806-659	15	wk6- 2 -1c	2985		1089	1054
			16	wk6- 2 -1c-dup	2980			
			17	wk6- 2 -2p	414			
			18	wk6- 2 -2p-dup	423			
			19	wk6- 2 -2c	2113			
			20	wk6- 2 -2c-dup	2560			
			21	wk6- 2 -3p	62			
			22	wk6- 2 -3p-dup	110			
			23	wk6- 2 -3c	140			
			24	wk6- 2 -3c-dup	93			
			30	wk6- 2 -1-a	1191	samples with		
			31	wk6- 2 -1-b	992	suffix a-e		
			32	wk6- 2 -1-c	800	were taken		
			33	wk6- 2 -1-d	729	after remix		
			34	wk6- 2 -1-e	743			
8	6/22/88	8806-772	11	wk8- 2 -1c-a	142	samples with	558	865
			12	wk8- 2 -1c-b	113	"b" suffix		
			13	wk8- 2 -2p-a	101	are dups of		
			14	wk8- 2 -2p-b	92	"a" samples		
			15	wk8- 2 -2c-a	2067			
			16	wk8- 2 -2c-b	2321			
			17	wk8- 2 -3p-a	157			
			18	wk8- 2 -3p-b	214			
			19	wk8- 2 -3c-a	185			
			20	wk8- 2 -3c-b	192			
10	6/7/88		8	wk10- 2 -1c	70		59	22
			9	wk10- 2 -2p	43			
			10	wk10- 2 -2c	41			
			11	wk10- 2 -3p	47			
			12	wk10- 2 -3c	92			
14	8/4/88	8808-229	14	wk14- 2 1c	61		34	26
			14	wk14- 2 dup	24			
			14	wk14- 2 hom	20			
			14	wk14- 2 hom dup	13			
			15	wk14- 2 2p	56			
			15	wk14- 2 dup	27			
			15	wk14- 2 hom	49			
			15	wk14- 2 hom dup	27			
			16	wk14- 2 2c	69			
			16	wk14- 2 dup	20			
			16	wk14- 2 hom	41			
			16	wk14- 2 hom dup	110			
			39	wk14- 2 3p	22			
			39	wk14- 2 dup	34			
			39	wk14- 2 hom	22			
			39	wk14- 2 hom dup	50			
			40	wk14- 2 3c	10			
			40	wk14- 2 dup	2			
			40	wk14- 2 hom	6			
			40	wk14- 2 hom dup	21			

GRAPH DATA

Time (days)	ave NC (mg/Kg)	ave+ stdev	ave - stdev
0	3039	7640	-1562
20	1485	3199	-229
41	1089	2143	35
55	558	1423	-307
70	59	81	37
98	34	60	8
151	54	94	13

Table C-2. BAAP Composting Project - Analytical Sample Log - Nitrocellulose - Pile #2

22	9/26/88	wk22 1	21	54	41
		wk22 2	39		
		wk22 3	22		
		wk22 4	70		
		wk22 5	117		

Table C-3. BAAP Composting - Bagged Sample Log - Nitrocellulose - Piles 1 and 2

Time (days) = 0			
Batch #	Sample	Client ID	NC (mg/Kg)
8805-261	-1	wk0 -.03NC	6447
	-2	wk0 -.05NC	12963
	-3	wk0 -.075NC	15568
	-4	wk0 -.10NC	23605

Time (days) = 42 Pile #1 mesophilic			
Batch #	Sample	Client ID	NC (mg/Kg)
8806-659	35	wk6 1- 3a	15294
	36	wk6 1- 3b	no data
	37	wk6 1- 5a	38676
	38	wk6 1- 5b	no data
	39	wk6 1- 5c	no data
	40	wk6 1- 7.5a	44117
	41	wk6 1- 7.5b	67692
	42	wk6 1- 7.5c	61231
	43	wk6 1- 10a	61666
	44	wk6 1- 10b	72131
	45	wk6 1- 10c	67796

Time (days) = 42 Pile #2 thermophilic			
Batch #	Sample	Client ID	NC (mg/Kg)
8806-659	46	wk6 2- 3a	324
	47	wk6 2- 3b	93
	48	wk6 2- 3a	378
	49	wk6 2- 5b	no data
	50	wk6 2- 7.5a	368
	51	wk6 2- 7.5b	648
	52	wk6 2- 7.5c	746
	53	wk6 2- 10a	421
	54	wk6 2- 10b	163
	55	wk6 2- 10c	248

Time (days) = 98 Pile #1 mesophilic			
Batch #	Sample	Client ID	NC (mg/Kg)
8808-229	1	wk1 1- 3a	155
	1	wk1 1- 3b	206
	1	wk1 1- 5a	124
	2	wk1 1- 10a	459
	2	wk1 1- 10b	435
	2	wk1 1- 10c	264
	3	wk1 1- 10d	1312
	3	wk1 1- 10e	1131
	3	wk1 1- 10f	1165

Time (days) = 98 Pile #2 thermophilic			
Batch #	Sample	Client ID	NC (mg/Kg)
8808-229	4	wk1 2- 3a	57
	4	wk1 2- 3b	57
	4	wk1 2- 3c	68
	5	wk1 2- 5a	42
	5	wk1 2- 5b	39
	5	wk1 2- 5c	39
	6	wk1 2- 7.5a	32
	6	wk1 2- 7.5b	30
	6	wk1 1- 7.5c	48
	7	wk1 2- 7.5d	55
	7	wk1 2- 7.5e	55
	7	wk1 2- 7.5f	73
	8	wk1 2- 10a	96
	8	wk1 2- 10b	92
	8	wk1 2- 10c	103

BAR GRAPH DATA (mg/Kg)

nominal conc	pile	day 0 #1,2	42 #1	42 #2	98 #1	98 #2
3%		6447	15294	209	162	61
5%		12963	38676	378		40
7.5%		15568	57680	587		52
10%		23605	67198	277	794	97

LINE GRAPH DATA

PILE 1

day	3%	5%	7.5%	10%
0	6447	12963	15568	23605
42	15294	38676	57680	67198
98	162			794

PILE 2

day	3%	5%	7.5%	10%
0	6447	12963	15568	23605
42	209	378	587	277
98	61	40	52	97

Table C-4. BAAP Composting Project - Analytical Sample Log - Nitrocellulose, Pile 3

Date	Day	RFW ID#	Client ID	NC (ug/g)	mean NC	stdev NC	mean+ stdev	mean- stdev
9/27/88	0	8809 853	3-1	7267				
			3-2	7561				
			3-3	7062				
			3-4	6463				
			3-5	5909				
			3-6	8389				
			3-7	8625				
			3-8	9200				
			3-9	9875				
			3-10	8718	7907	1259	9166	6648
10/26/88	29	8810 179	3-1p	1120				
			3-2p	313				
			3-2c	129				
			3-3p	193				
			3-3c	180	387	415	802	-28
11/15/88	49	8811L 511	3-1-a	776				
			3-1-b	745				
			3-2-a	979				
			3-2-b	921				
			3-3-a	770				
			3-3-b	887				
			3-4-a	1129				
			3-4-b	753	870	136	1006	734
1/9/88	101	8901L 111	3-1	49				
			3-2	32				
			3-3	45				
			3-4	8				
			3-5	18	30	17	48	13

GRAPH DATA			
Day	mean NC	mean+ stdev	mean- stdev
0	7907	9102	6712
29	387	758	16
49	870	998	743
101	30	46	15

Table C-5. BAAP Composting Project - Analytical Sample Log - Nitrocelulose, Pile #4

Date	Day	RFW ID#	Client ID	NC ug/g	Mean NC	StDev NC
9/28/88	0	8809 853	4-1	15663		
			4-2	14167		
			4-3	14722		
			4-4	11394		
			4-5	13804		
			4-6	12287		
			4-7	12857		
			4-8	10944		
			4-9	14000		
			4-10	11023	13086	1641
10/26/88	28	8810 179	4-1c	295		
			4-2a	153		
			4-2b	372		
			4-3c	297		
			4-3d	328	289	82
11/15/88	49	8811L 511	4-1-a	908		
			4-1-b	898		
			4-2-a	896		
			4-2-b	995		
			4-3-a	1139		
			4-3-b	1102		
			4-4-a	1088		
			4-4-b	944	996	100
1/9/89	101	8901L 111	4-1	12		
			4-2	2		
			4-3	2		
			4-4	9		
			4-5	56	16	23

GRAPH DATA

Day	mean NC	mean+ stdev	mean- stdev
0	13086	14727	11445
28	289	371	207
49	996	1096	896
101	16	39	-6

Table C-6. BAAP Composting Project - Bagged Sample Log - Nitrocellulose - Pile #3
Bagged Compost - Spiked w/ nitrocellulose (NC)

Date	Day	RFW Batch	ID	NC ug/g	Mean	StDev	Mean+Std	Mean-Std
9/27/88	0	8809 853	5%-1	14207				
			5%-2	19268				
			5%-3	15976				
			5%-4	13963				
			5%-5	10732				
			5%-6	11707	14309	3068	17377	11241
10/26/88	29	8810 179	5%-1	14366				
			5%-2	17372				
			5%-3	15413	15784	1635	17418	14149
11/15/88	49	8811L 511	5%-A	2925				
			5%-B	202				
			5%-C	1164	1430	1381	2811	49
1/9/99	101	8901L 111	5%-A	40				
			5%-B	2473				
			5%-C	2474	1662	1405	3067	257
9/27/88	0	8809 853	15%-1	45811				
			15%-2	75676				
			15%-3	95270				
			15%-4	62567				
			15%-5	36013				
			15%-6	77705	65507	21929	87436	43577
10/26/88	29	8810 179	15%-1	50866				
			15%-2	42111				
			15%-3	15121	36033	18632	54664	17401
11/15/88	49	8811L 511	15%-A	15846				
			15%-B	11507				
			15%-C	20581				
			15%-D	16299				
			15%-E	31350				
			15%-F	30414	21000	8182	29181	12818
9/27/88	0	8809 853	30%-1	125000				
			30%-2	106081				
			30%-3	110811				
			30%-4	141892				
			3-%-5	134460				
			30%-6	68918	114527	26158	140685	88369
10/26/88	29	8810 179	30%-1	59397				
			30%-2	86551				
			30%-3	74885	73611	13622	87233	59989
11/15/88	49	8811L 511	30%-A	4062				
			30%-B	5493				
			30%-C	6041	5199	1022	6220	4177
1/9/89	101	8901L 111	30%-A	1434				
			30%-B	2441				
			30%-C	3489	2455	1028	3482	1427

Table C-6. BAAP Composting Project - Bagged Sample Log - Nitrocellulose - Pile #3
(table continued)

9/27/88	0	8809 853	60%-1	189706				
			60%-2	241176				
			60%-3	216176				
			60%-4	233823				
			60%-5	191176				
			60%-6	239706	218627	23578	242206	195049
10/26/88	29	8810 179	60%-1	189957				
			60%-2	224385				
			60%-3	244793	219712	27715	247427	191997
11/15/88	49	8811L 511	60%-A	133722				
			60%-B	129069				
			60%-C	170100	144297	22467	166764	121830
1/9/89	101	8901L 111	60%-A	79049				
			60%-B	72060				
			60%-C	55326	68811	12192	81003	56619
9/27/88	0	8809 853	80%-1	242647				
			80%-2	155882				
			80%-3	152941				
			80%-4	155882				
			80%-5	148529				
			80%-6	130733	164436	39457	203893	124979
10/26/88	29	8810 179	80%-1	162113				
			80%-2	150625				
			80%-3	163433	158724	7045	165768	151679
1/9/89	101	8901L 111	80%-1	178234				
			80%-2	191755				
			80%-3	198238				
			80%-4	239082				
			80%-5	212395				
			80%-6	198315	203003	20855	223858	182148

Table C-7. BAAP temperature data - strip chart recorder data
see NSP 9, 14, 16 in BAAP Composting notebook (FE 056)
Compost Piles 1 and 2, all temperatures in Centigrade
probes 1-5 = pile #1, probes 6-10 = pile #2

chart paper page	day	time	probe Pile #1 1	2	3	4	5	Pile #2 6	7	8	9	10
1	0	1302	23	23	23	23	28	16	16	16	16	16
	0	1702	26	28	36	29	39	16	17	17	17	17
	0	2102	25	34	44	32	47	17	17	18	17	18
	1	102	31	40	49	33	58	19	19	21	19	21
	1	502	32	49	58	33	67	22	26	25	25	31
	1	902	33	57	64	34	71	28	37	29	35	43
	1	1302	35	62	68	37	72	32	50	36	44	57
	1	1702	37	66	71	39	72	37	63	47	51	66
	1	2102	46	66	65	46	37	42	72	55	56	71
	2	502	36	31	38	37	7	52	72	68	70	76
	2	902	36	28	40	36	8	66	70	75	67	64
	2	1302	34	28	42	37	8	55	45	61	32	23
	2	1702	35	29	44	38	8	51	43	61	31	22
	2	2148	35	32	48	38	9	49	54	64	31	21
	3	148	34	33	51	37	9	49	65	68	32	21
	3	548	33	32	54	37	9	49	69	71	35	21
	3	1345	32	37	66	42	9	51	43	69	25	13
	3	1745	32	46	67	45	11	52	42	68	24	13
	3	2145	32	55	67	48	12	52	36	69	23	13
	4	145	31	56	70	44	13	53	31	70	22	14
	4	545	31	56	73	45	13	53	29	74	22	13
	4	945	30	55	76	44	13	52	29	76	21	11
	4	1345	32	66	75	44	13	54	37	77	23	12
	4	1745	32	55	66	52	13	51	27	75	21	10
	4	2145	32	46	59	56	14	51	29	76	21	11
	5	545	31	47	61	52	13	51	38	77	25	12
2	5	856	32	51	65	49	13	51	36	76	26	12
	5	1258	31	43	56	46	9	55	36	76	29	13
	5	1658	31	34	51	41	12	57	32	77	37	13
	5	2058	31	27	48	36	13	57	26	73	41	13
	6	58	31	24	47	32	13	57	23	72	39	13
	6	458	31	22	47	29	11	57	23	71	39	13
	6	858	31	21	45	27	10	57	23	70	40	14
	6	931	31	21	45	27	10	57	23	70	40	14
	6	1258	32	19	41	24	9	56	24	70	43	15
	6	1317	31	19	41	24	9	56	25	70	43	15
	6	1658	33	20	51	25	11	56	31	72	48	16
	6	2058	32	21	52	24	12	56	42	74	51	17
	7	58	33	21	38	22	13	56	61	76	51	19
	7	458	33	19	27	19	8	56	72	77	55	21
	7	858	32	17	24	18	6	56	74	77	61	24
	7	1453	31	17	29	19	8	55	70	76	61	27
	7	1544	30	17	31	19	8	55	69	75	59	28
	7	1853	30	19	33	19	8	53	70	75	63	31
	7	2253	29	21	36	21	10	53	68	74	63	35
	8	253	29	22	38	21	12	53	63	76	64	42
	8	653	29	23	41	21	13	53	59	73	63	48
	8	1053	29	26	43	22	14	53	58	72	60	48
	8	1453	36	27	39	22	16	53	59	72	48	45
	8	1853	39	25	41	20	16	53	61	74	39	41
	8	2253	32	23	33	19	16	52	54	74	36	42
	9	253	32	23	31	19	16	52	53	72	37	45
	9	653	32	23	28	20	16	52	52	71	53	46
	9	1053	31	22	25	21	16	52	55	68	46	47
	9	1453	32	22	23	21	13	53	57	65	39	36
	9	1853	32	21	21	21	21	53	48	61	40	29
	9	2253	33	22	20	21	17	53	44	59	39	22
	10	253	31	22	19	22	15	52	43	59	38	36
	10	653	31	21	18	22	14	52	42	59	39	39

Table C-7 (cont.)

10	904	31	21	18	22	14	52	45	62	41	46
10	1302	33	22	19	24	19	54	44	67	34	43
10	1702	33	24	19	27	23	54	38	62	29	34
10	2102	34	26	21	29	31	55	31	55	28	28
11	102	42	26	17	29	17	54	26	55	28	23
11	502	34	20	14	27	13	56	28	58	33	27
11	902	34	18	14	28	14	49	26	55	22	24
11	1302	34	18	14	29	14	36	27	51	17	27
11	1702	34	18	14	28	16	29	29	49	15	34
11	2102	36	18	14	28	18	29	31	52	15	51
12	102	34	19	16	27	17	30	33	58	16	63
12	502	34	19	16	27	14	34	33	66	17	70
12	902	34	19	17	25	9	48	36	71	22	72
12	1116	36	18	17	25	8	56	29	67	44	39
12	1516	36	19	17	32	11	59	32	69	58	62
12	1916	36	21	18	33	14	59	29	64	51	41
12	2316	36	22	19	33	18	59	30	68	49	41
13	316	36	23	21	33	19	59	32	71	48	41
13	716	36	23	21	33	22	59	36	71	46	39
13	1116	36	24	22	33	27	59	46	72	55	42
13	1516	37	27	23	35	38	55	64	70	59	38
13	1916	39	31	22	39	39	51	69	67	54	41
13	2316	52	39	19	41	17	51	67	68	59	45
14	316	39	29	18	27	17	54	67	71	63	57
14	716	38	27	19	27	16	53	66	62	58	64
14	1047	37	26	20	28	14	52	54	60	37	68
14	1417	42	27	21	30	13	57	53	62	38	64
14	1817	41	27	21	30	12	57	50	66	37	66
14	2217	41	27	21	30	13	57	48	69	36	64
15	217	61	26	19	29	14	58	44	72	39	62
15	617	40	26	19	29	14	53	29	66	36	36
15	935	41	26	19	29	13	51	32	70	41	38
15	1017	41	26	19	30	12	49	31	70	41	39
15	1417	43	26	19	31	11	49	37	73	48	39
15	1817	43	26	19	32	13	47	46	73	51	37
15	2217	43	25	20	32	16	46	44	73	53	35
16	527	42	26	21	33	20	46	44	72	53	35
16	927	43	26	20	34	22	47	43	70	55	35
16	1327	43	27	21	36	23	47	42	66	53	33
16	1727	43	27	21	37	20	44	36	51	45	31
16	2127	43	26	19	35	17	44	31	48	51	30
17	127	42	25	17	33	16	49	31	49	48	31
17	527	42	26	17	32	16	49	33	52	45	32
17	854	42	26	17	32	14	48	34	53	41	33
17	1254	46	27	17	32	14	49	36	55	34	35
17	1432	46	27	17	31	14	48	37	55	31	36
17	1654	49	27	17	31	16	46	46	56	28	39
17	2054	49	26	16	28	15	46	43	55	23	49
18	54	49	25	17	27	15	41	41	55	21	55
18	454	49	25	17	26	13	37	33	57	19	64
18	854	49	24	17	25	11	36	31	59	19	66
18	1254	49	24	18	24	9	37	28	61	22	63
18	1654	49	23	19	22	10	45	25	63	39	59
18	2034	49	23	19	2'	13	47	23	67	44	61
19	54	49	22	18	19	14	47	23	69	46	63
19	454	49	22	18	18	12	46	23	71	44	66
19	854	49	22	18	18	9	47	24	70	46	66
19	1254	14	25	21	21	8	52	24	71	50	66
19	1533	15	28	21	21	9	54	24	72	51	63
19	1935	16	33	23	21	11	52	24	72	51	67
19	2355	18	41	26	23	11	48	24	72	49	70
20	335	21	39	28	24	13	46	26	72	48	70
20	735	22	37	31	23	14	67	27	72	52	72
20	1428	28	44	36	28	18	48	29	72	57	71
20	1515	29	45	35	28	18	47	29	71	56	71
20	1828	34	48	36	32	21	47	32	72	57	70
20	2228	34	48	38	33	26	46	34	72	61	68

Table C-7 (cont.)

	21	228	36	48	39	33	27	46	36	71	61	67
	21	628	36	48	39	34	31	47	37	70	62	67
	21	936	37	48	39	33	36	47	39	70	62	66
5	21	1337	32	52	57	51	26	46	42	70	61	67
	21	1757	31	58	66	57	24	46	42	69	65	71
	21	2157	31	64	68	64	28	48	48	70	64	73
	22	157	32	63	66	64	29	46	53	70	62	72
	22	557	31	61	65	66	29	46	55	70	61	70
	22	957	31	61	65	68	28	47	58	69	62	72
	22	1105	31	59	66	68	28	47	58	70	62	72
	22	1357	26	48	59	59	23	44	36	54	37	48
	22	1757	26	45	61	60	23	42	40	59	37	52
	22	2157	26	41	59	58	24	42	46	63	38	55
	23	157	26	33	53	48	24	43	53	65	41	58
	23	557	26	33	51	41	23	45	62	67	47	60
	23	957	26	33	52	39	24	46	52	67	53	62
	23	1357	26	32	56	39	25	46	39	66	58	62
	23	1757	26	33	59	41	25	43	29	63	57	63
	23	2157	26	32	60	43	25	41	28	63	56	63
	24	157	27	29	53	42	26	41	27	63	[illegible]	63
	24	557	26	28	49	39	24	39	27	63	58	62
	24	802	25	27	48	39	23	39	23	62	56	61
	24	1204	25	28	53	37	27	39	18	59	63	58
	24	1604	26	28	52	41	26	41	18	59	64	54
	24	2004	25	27	45	44	22	41	19	59	58	57
	25	4	25	26	42	43	21	38	19	62	54	63
	25	404	26	25	38	41	20	38	21	63	54	64
	25	804	25	25	36	39	17	37	21	64	57	63
	25	1204	26	25	36	39	15	39	20	64	69	62
	25	1604	25	26	36	39	14	45	21	66	69	56
	25	2004	25	26	37	41	13	47	19	66	63	52
	26	4	26	26	37	42	14	41	18	64	52	58
	26	404	25	26	37	45	14	37	18	63	49	61
	26	804	26	26	37	46	13	37	19	63	52	64
	26	915	24	25	37	47	13	37	19	63	51	64
	26	1237	25	26	38	49	11	48	17	53	49	56
	26	1637	25	26	41	53	9	49	17	54	48	55
	26	2037	25	27	45	56	9	49	17	53	43	50
	27	37	25	27	48	57	10	49	17	53	42	49
	27	437	25	27	52	58	12	48	18	56	44	48
	27	837	25	28	57	57	13	48	19	57	46	46
	27	1237	26	28	60	56	12	47	21	58	47	42
	27	1637	25	28	57	55	11	43	23	57	47	36
	27	2037	25	28	54	54	14	41	24	58	44	34
	28	37	26	29	52	54	18	39	26	61	43	33
	28	437	26	29	48	49	20	38	27	63	43	33
	28	837	26	27	42	42	17	37	27	61	43	32
	28	1031	26	27	42	39	6	37	28	52	37	29
6	28	1432	26	26	41	16	37	36	29	54	31	27
	28	1832	25	27	41	36	19	34	31	57	28	27
	28	2232	26	27	41	36	21	33	33	59	29	27
	29	232	26	26	37	33	19	32	36	61	42	26
	29	632	26	25	36	31	17	34	39	61	54	26
	29	1032	26	26	37	32	18	[illegible]	43	62	47	25
	29	1432	26	27	40	33	17	[illegible]	17	63	34	25
	29	1832	26	27	42	34	20	28	49	62	25	26
	29	2232	27	26	40	31	21	27	52	63	31	26
	30	232	27	26	38	28	18	29	52	64	52	27
	30	632	26	27	40	28	17	34	52	64	61	28
	30	1032	26	27	42	30	16	37	56	67	52	[illegible]
	30	1432	26	28	44	32	17	32	55	67	34	29
	30	1832	27	28	45	33	21	29	53	63	28	33
	30	2232	27	27	43	30	21	28	52	63	33	34
	31	232	27	27	42	28	18	32	52	62	49	36
	31	632	26	27	41	28	17	38	52	61	56	37
	31	1032	26	28	42	29	16	39	55	63	49	39
	31	1432	26	29	44	31	18	37	56	66	38	44

Table C-7 (cont.)

	31	1832	27	29	44	31	22	34	53	63	35	48
	31	2232	27	28	42	27	21	34	52	61	46	51
	32	232	27	28	51	25	18	39	52	61	53	53
	32	632	26	29	41	26	17	42	53	61	52	56
	32	750	27	30	40	27	17	42	54	62	52	58
	32	1151	28	33	42	29	17	43	56	62	49	59
	32	1551	28	34	43	29	18	44	63	64	48	64
	32	1951	28	34	42	29	22	45	68	69	51	68
	32	2351	29	33	40	27	22	47	68	72	55	73
	33	351	28	32	39	25	20	47	67	74	56	74
	33	751	28	33	39	26	19	48	65	75	58	76
	33	1151	30	34	42	28	21	42	49	64	42	53
	33	1551	31	37	47	29	23	43	52	62	41	59
	33	1951	31	42	45	29	22	46	56	62	42	62
	33	2351	31	39	44	28	24	46	56	61	[illegible]	62
	34	351	31	37	42	25	22	46	56	59	[illegible]	61
	34	751	31	36	43	25	22	46	42	57	39	59
	34	1012	30	37	42	26	21	45	36	57	39	[illegible]
7	34	1414	31	39	43	26	21	49	25	53	53	63
	34	1814	31	38	44	27	21	49	21	54	51	57
	34	2214	31	38	44	26	22	49	21	54	46	56
	35	214	31	37	43	24	21	48	21	57	45	56
	35	614	31	36	42	24	19	48	22	58	46	56
	35	1014	31	36	42	23	18	49	22	58	51	53
	35	1254	30	36	42	23	18	49	21	57	48	48
	35	1414	31	36	43	24	18	49	22	58	46	48
	35	1814	32	38	45	25	19	49	22	62	44	49
	35	2214	33	41	43	23	19	49	22	65	44	49
	36	214	33	41	42	23	19	48	23	68	43	51
	36	614	32	39	41	22	19	48	23	69	42	52
	36	1014	33	39	41	21	21	47	24	68	44	54
	36	1614	33	38	41	21	21	45	25	62	45	56
	36	1814	33	38	41	21	19	44	24	57	44	59
	36	2214	33	38	42	21	21	45	26	57	46	62
	37	214	33	37	42	20	21	44	27	58	46	64
	37	614	32	35	41	19	21	43	27	58	46	66
	37	1014	33	36	41	19	22	42	28	55	45	67
	37	1414	33	36	41	19	22	41	29	52	46	67
	37	1814	33	36	41	19	23	41	31	51	48	67
	37	2214	33	36	41	19	23	42	33	52	51	66
	38	214	33	34	39	19	24	41	34	53	53	66
	38	614	33	34	38	19	25	41	36	53	51	66
	38	915	34	34	38	19	25	41	38	55	49	66
	38	1315	34	37	41	21	24	40	41	52	48	66
	38	1715	33	39	44	22	27	39	42	53	48	67
	38	2115	32	39	48	23	29	41	45	55	51	67
	39	115	32	37	49	24	29	41	48	58	52	67
	39	515	32	37	49	26	31	41	51	62	52	67
	39	915	33	36	33	32	25	31	29	31	31	30
	39	1315	33	33	32	33	33	31	32	31	31	31
8	39	1715	31	31	31	31	32	30	29	29	30	29
	39	2115	33	32	33	32	32	32	31	31	31	31
	40	115	34	33	33	32	33	33	32	32	32	33
	40	515	34	33	33	33	33	33	33	33	33	33
	40	915	34	33	34	33	33	33	33	33	33	37
	40	1261	34	34	34	34	34	34	34	34	34	41
	40	1315	34	33	34	34	33	34	34	34	34	41
	40	1715	35	34	34	36	34	36	34	34	35	43
	40	2115	34	34	34	37	35	36	36	36	36	44
	41	115	36	35	34	38	36	37	36	37	36	46
	41	515	35	34	34	39	35	38	37	37	37	47
	41	915	36	34	33	41	34	39	38	39	38	48
	41	1315	36	34	33	42	34	41	39	40	38	48
	41	1715	36	34	33	43	33	42	39	41	39	48
	41	2115	36	34	33	43	33	42	40	42	39	48
	42	115	36	33	33	44	33	42	40	42	40	48
	42	515	36	33	33	44	32	42	41	43	41	48

Table C-7 (cont.)

	42	915	36	33	32	44	32	43	41	44	42	48
	42	1438	36	33	36	46	31	43	41	43	43	48
	42	1838	37	34	36	44	30	43	40	42	43	48
	42	2238	37	34	34	43	30	43	41	43	43	48
	43	238	36	33	33	43	31	44	41	43	44	48
	43	638	36	33	33	43	31	44	41	42	44	48
	43	1038	36	33	32	43	31	44	42	42	45	47
	43	1438	36	33	21	43	31	44	42	42	46	47
	43	1838	36	33	31	43	31	44	42	42	47	47
	43	2238	36	33	31	43	30	44	42	42	47	47
	44	238	36	32	29	43	31	44	42	42	47	46
	44	638	35	32	29	43	31	44	42	42	48	46
	44	1038	34	32	29	44	31	45	43	42	48	46
	44	1438	35	31	29	44	31	45	43	42	48	46
	44	1838	34	31	29	44	30	45	43	42	49	47
	44	2238	35	31	30	44	31	46	44	43	50	46
	45	238	34	31	30	44	31	45	43	43	50	46
	45	638	34	31	31	44	31	45	44	43	51	46
	45	1038	34	31	30	45	31	45	44	43	51	46
	45	1438	34	31	31	44	30	45	45	43	51	46
9	45	1601	34	31	31	45	31	46	45	43	51	46
	45	2001	34	31	31	44	31	46	45	43	52	46
	46	1	34	31	32	45	31	46	46	44	52	47
	46	401	36	32	32	45	31	46	46	44	52	47
	46	801	35	32	33	46	32	47	46	44	53	47
	46	1201	34	31	33	45	31	47	47	45	53	46
	46	1601	36	32	34	45	31	47	47	48	53	46
	46	2001	36	32	35	45	32	48	48	47	53	47
	47	1	36	32	34	44	31	48	48	46	53	46
	47	401	36	32	34	43	31	48	48	46	53	47
	47	801	36	33	33	43	32	48	48	46	52	47
	47	1201	36	33	33	43	32	49	48	46	52	47
	47	1601	36	33	33	43	32	49	48	46	52	47
	47	2001	36	33	32	43	31	48	48	45	52	46
	48	1	36	33	32	43	31	48	49	46	52	47
	48	401	36	33	32	43	31	48	48	45	52	47
	48	801	35	33	32	43	32	48	48	44	51	47
	48	1201	36	33	33	43	31	48	48	45	52	47
	48	1731	36	33	31	42	31	48	48	44	52	47
	48	2131	36	33	31	39	31	48	48	44	52	47
	49	131	36	34	31	39	31	49	49	44	52	47
	49	531	34	33	29	38	31	49	48	44	52	47
	49	931	35	33	29	38	32	49	48	44	52	47
	49	1331	34	33	29	38	32	49	48	45	52	47
	49	1731	34	33	28	38	32	48	48	45	52	47
	49	2131	34	33	28	38	31	49	48	44	52	47
	50	131	34	33	27	37	32	49	48	44	52	47
	50	531	33	33	27	37	31	49	48	44	52	47
	50	931	33	33	27	37	32	49	48	44	52	47
	50	1331	34	33	27	38	32	49	48	44	52	48
	50	1731	33	33	27	37	33	49	48	45	52	48
	50	2131	33	33	27	38	33	50	48	44	52	48
	51	131	34	33	27	37	33	51	49	45	52	48
	51	531	33	33	28	38	33	51	49	45	53	43
	51	931	33	33	28	38	33	51	49	45	53	38
	51	1331	34	34	28	38	33	51	48	44	53	37
	51	1731	34	34	28	38	33	49	48	44	53	40
	51	2131	34	35	29	38	34	49	47	43	53	42
	52	131	33	34	29	38	34	49	47	43	53	43
	52	531	34	34	29	39	34	49	47	43	53	43
	52	931	34	35	29	39	35	49	47	43	54	44
	52	1331	34	36	30	39	36	49	46	43	53	43
	52	1731	34	35	29	40	36	49	46	43	53	44
	52	2131	34	36	30	40	36	48	46	43	53	44
	53	131	35	36	31	40	36	48	46	43	53	44
	53	531	35	36	32	41	37	49	46	44	53	44
10	53	828	36	37	33	41	37	48	46	43	53	45

Table C-7 (cont.)

	53	1227	36	37	33	38	37	49	48	44	46	45
	53	1627	36	37	32	38	37	48	47	44	49	46
	53	2027	36	36	33	38	36	48	47	43	49	46
	54	27	36	36	33	38	36	49	47	43	49	46
	54	427	36	37	34	38	36	49	47	43	49	46
	54	827	36	37	35	39	35	48	47	43	48	46
	54	1137	36	37	36	39	36	49	47	42	48	47
	54	1627	36	37	36	39	35	48	47	42	48	47
	54	2027	37	37	37	41	35	48	46	42	48	47
	55	27	37	37	39	41	34	48	46	42	48	47
	55	427	37	36	40	43	35	48	47	42	48	47
	55	827	39	36	42	46	34	48	46	42	48	47
	55	1227	40	37	44	49	34	48	46	43	48	47
	55	1627	41	37	46	51	34	48	47	42	47	47
	55	2027	43	37	48	53	34	48	47	43	48	46
	56	27	43	37	49	55	34	48	46	42	48	46
	56	427	44	37	50	56	34	48	47	43	47	45
	56	827	46	37	51	58	35	48	46	42	47	46
	56	1227	47	38	51	59	35	48	47	42	47	45
	56	1627	49	38	51	61	36	48	46	42	47	46
	56	2027	49	38	51	62	36	47	47	43	48	46
	57	27	49	39	50	62	37	47	46	43	47	46
	57	427	50	40	50	63	37	48	47	43	48	46
	57	827	51	41	49	62	39	47	47	43	48	46
	57	1227	51	42	48	62	39	47	48	43	48	46
	57	1627	51	42	48	61	39	47	47	43	48	45
	57	2027	50	42	47	60	39	47	47	44	48	45
	58	28	50	42	46	59	41	48	48	44	48	45
	58	428	49	43	45	59	41	47	47	43	48	46
	58	828	49	42	45	59	41	47	47	44	48	46
	58	1228	49	44	46	59	41	47	47	43	48	46
	58	1628	49	46	49	59	41	47	47	44	48	46
	58	2028	49	46	53	60	41	47	47	43	48	46
	59	28	40	46	56	61	41	48	48	44	48	46
	59	428	49	46	56	61	41	48	48	44	48	46
	59	828	49	46	54	62	41	47	48	44	48	46
11	59	1116	48	46	53	63	41	48	48	44	48	46
	59	1513	49	46	52	63	40	48	48	43	48	46
	59	1913	49	46	51	63	39	48	48	44	49	46
	59	2313	49	47	50	64	40	48	48	45	49	46
	60	313	49	47	48	63	39	47	47	44	48	46
	60	713	49	46	48	64	41	48	48	44	49	47
	60	1113	49	47	46	64	40	48	48	44	49	46
	60	1513	49	47	47	64	41	48	48	45	49	47
	60	1913	49	47	49	64	40	48	48	45	49	47
	60	2313	49	47	49	64	40	48	48	45	49	47
	61	313	49	48	53	63	40	48	48	45	49	48
	61	713	49	48	54	63	40	49	48	45	50	49
	61	1113	48	47	52	62	40	48	48	45	51	49
	61	1455	48	48	51	62	41	49	48	45	50	49
	61	1854	48	48	50	62	41	49	48	46	50	51
	61	2254	48	48	48	62	40	49	47	45	50	51
	62	254	49	48	48	62	41	49	48	45	50	52
	62	654	49	49	48	62	40	49	48	46	51	52
	62	1054	49	49	49	62	40	51	48	46	51	53
	62	1454	49	49	49	63	39	51	48	46	51	53
	62	1854	51	49	50	63	41	51	48	47	51	53
	62	2234	51	51	51	64	40	51	47	48	51	54
	63	254	52	50	49	64	40	51	47	48	51	54
	63	654	52	51	49	66	41	52	47	48	51	55
	63	1026	53	51	49	66	41	52	47	48	51	55
12	63	1516	53	51	49	67	41	52	47	49	52	55
	63	1916	54	52	48	67	42	53	47	49	52	55
	63	2316	55	52	49	67	42	53	47	49	52	55
	64	316	55	52	49	67	42	53	47	50	52	55
	64	716	55	52	49	68	42	53	47	50	52	55
	64	1116	55	53	49	68	42	53	47	51	52	55

Table C-7 (cont.)

64	1516	55	53	49	69	43	54	47	51	52	55
64	1916	55	53	49	69	42	34	48	51	53	55
64	2316	56	54	51	69	42	54	48	51	53	56
65	316	55	54	50	69	42	54	49	52	53	55
65	716	55	55	50	69	43	53	48	51	53	55
65	1116	55	55	49	69	43	54	48	51	53	55
65	1516	55	55	50	69	43	54	49	52	53	55
65	1916	55	55	51	69	43	54	49	52	53	55
65	2316	55	56	51	69	43	54	49	52	54	55
66	316	54	55	51	69	43	54	49	52	54	55
66	716	54	56	51	68	43	54	50	52	54	55
66	1116	54	56	52	68	43	55	51	52	54	56
66	1516	54	56	52	69	44	55	51	52	55	55
66	1916	54	56	52	68	43	54	51	53	55	55
66	2316	54	56	53	68	44	55	52	53	55	55
67	316	54	57	53	68	44	55	52	52	54	55
67	714	54	56	53	68	44	55	52	53	55	56
67	1116	53	56	53	67	44	56	52	52	55	56
67	1455	53	56	53	68	44	55	53	53	55	56
67	1916	53	56	53	67	44	56	53	53	56	56
67	2316	53	57	54	67	44	55	53	53	55	55
68	316	53	57	54	67	44	56	53	53	56	52
68	716	53	57	55	68	44	55	53	53	56	49
68	1116	52	57	55	67	44	55	53	53	56	51
68	1516	54	57	55	67	44	55	53	53	56	51
68	1916	58	57	55	66	44	55	52	53	56	52
68	2316	58	57	56	66	43	55	52	53	56	52
69	316	58	57	56	67	43	54	52	52	56	52
69	716	58	56	56	66	43	54	52	52	57	53
69	1116	59	57	56	67	43	55	52	52	57	53
69	1516	59	57	56	66	43	54	52	52	56	53
69	1916	59	57	56	66	43	55	52	52	57	53
69	2316	59	57	57	66	43	55	53	52	56	53
70	317	60	57	57	66	43	54	53	53	56	54
70	717	61	57	58	67	44	54	53	52	56	54
70	1117	61	57	57	67	43	54	53	53	57	55
70	1335	61	58	58	67	44	55	53	53	56	55
70	1735	61	58	58	67	44	55	53	52	56	56
70	2135	62	58	58	67	45	55	54	53	56	56
71	315	62	58	58	68	45	55	53	53	56	56
71	935	62	59	58	68	46	55	53	53	57	49
71	1335	62	58	58	68	46	55	53	53	56	50
71	1735	62	59	58	68	46	54	53	53	57	51
71	2135	63	59	58	69	46	54	52	53	57	51
72	135	62	59	58	68	46	54	52	52	56	52
72	535	62	59	58	68	46	54	52	52	56	52
72	935	63	60	58	69	46	54	52	52	57	52
72	1335	62	61	59	69	47	54	52	52	56	53
72	1735	62	61	59	69	47	54	52	52	56	53
72	2135	62	61	59	69	47	54	52	52	56	54
73	135	62	61	59	69	47	54	52	52	56	54
73	535	62	61	59	69	47	54	52	52	56	54
73	806	63	62	59	69	47	55	52	52	56	55
73	1205	62	62	59	69	47	55	53	52	56	55
73	1605	62	62	59	69	47	54	52	52	56	56
73	2005	52	62	59	63	47	55	53	52	56	56
74	6	62	62	59	68	47	55	53	53	56	56
74	406	62	62	59	68	47	55	53	52	56	56
74	806	62	63	59	69	47	55	53	52	55	57
74	1206	62	63	59	68	46	55	53	52	55	56
74	1606	62	63	59	69	47	56	53	52	56	51
74	2006	63	64	59	70	47	55	52	52	55	50
75	6	63	63	59	70	47	55	52	52	56	51
75	406	63	64	59	70	48	55	51	51	56	52
75	806	62	64	59	70	47	54	51	52	56	52
75	1435	63	64	59	71	48	54	51	52	55	53
75	1835	63	64	59	71	49	55	51	52	55	53

Table C-7 (cont.)

75	2235	63	65	59	70	49	54	51	52	56	54
76	235	63	65	59	71	49	54	51	52	56	54
76	635	63	65	59	71	49	54	51	52	56	54
76	1035	63	66	59	72	50	55	51	52	55	55
76	1435	63	66	59	71	50	55	51	52	55	55
76	1835	63	66	59	70	50	55	51	52	55	55
76	2235	63	67	59	70	51	55	52	52	55	56
77	235	63	37	59	70	51	55	51	52	55	56
77	635	64	67	59	69	51	55	52	52	55	56
77	1269	64	67	59	71	56	52	52	52	55	56
78	1742	62	63	58	67	54	56	52	53	55	51
78	2142	62	64	59	68	53	56	52	53	56	49
79	142	63	66	59	67	53	55	51	52	55	51
79	542	64	67	60	68	52	54	51	52	55	51
79	942	64	67	60	69	53	54	51	51	55	52
79	1342	66	68	60	70	53	54	51	51	55	53
79	1742	67	69	59	71	54	54	51	52	55	53
79	2142	67	69	60	71	55	54	51	52	54	53
80	142	67	69	60	72	55	54	50	52	55	53
80	542	68	70	61	72	56	54	51	52	55	54
80	942	69	70	61	73	56	54	51	52	55	54
80	1134	69	70	61	73	56	54	51	52	55	54
80	1535	68	70	61	73	57	55	51	52	55	55
80	1935	69	70	59	73	57	55	51	52	55	56
80	2335	69	70	60	72	58	55	51	52	56	56
81	335	70	70	61	72	58	55	52	52	55	56
81	735	69	69	60	72	58	55	51	52	55	56
81	1135	70	70	60	73	58	56	52	52	55	56
81	1535	69	69	59	72	58	56	52	53	55	56
81	1935	69	69	59	71	58	56	52	52	55	56
81	2335	70	70	60	69	59	56	52	53	55	56
82	335	70	70	59	69	58	55	52	52	55	52
82	735	70	69	59	68	59	56	52	53	55	52
82	1048	70	69	59	68	59	55	51	52	54	52
82	1449	70	69	59	68	59	55	51	52	54	52
82	1849	70	69	59	69	59	55	51	52	54	53
82	2249	70	69	59	69	59	54	51	52	54	53
83	249	70	69	59	69	59	54	51	52	54	53
83	649	70	69	59	70	60	54	50	52	54	53
83	1049	70	69	59	69	60	55	51	52	53	54
83	1449	70	69	59	69	61	54	51	52	53	55
83	1849	70	69	58	68	61	54	50	52	53	54
83	2249	70	69	58	67	61	54	50	52	53	55
84	249	71	69	59	68	61	54	50	52	53	55
84	649	70	69	58	68	62	54	51	52	53	55
84	1049	70	69	58	69	62	55	51	52	53	56
84	1459	71	68	58	69	62	54	50	52	52	56
84	1859	70	68	58	69	62	55	51	52	53	56
84	2259	70	67	58	69	62	54	50	52	53	56
85	259	71	67	58	70	63	55	50	52	53	56
85	659	70	67	58	70	63	54	50	52	53	56
85	1059	71	67	58	70	64	55	51	52	53	56
85	1459	71	67	37	70	64	55	51	52	53	56
85	1859	70	67	58	70	64	55	51	52	53	56
85	2259	71	67	58	71	66	55	51	52	53	56
86	259	72	67	57	69	65	55	51	52	53	56
86	659	71	66	57	69	66	55	51	52	53	57
86	1059	71	66	57	69	66	55	51	52	53	56
86	1459	71	66	57	70	67	56	52	52	53	56
86	1859	71	66	56	70	67	55	51	52	53	57
86	2259	71	66	57	70	68	56	52	53	53	57
87	259	71	66	57	69	68	56	51	52	53	57
87	659	71	66	56	68	69	56	52	52	53	57
87	1308	70	65	56	67	69	56	52	53	54	55
87	1715	72	66	56	67	70	56	52	53	54	56
87	2115	71	63	56	64	70	55	52	54	56	47
88	115	71	65	56	63	71	55	51	53	56	48

Table C-7 (cont.)

88	515	71	64	55	63	71	53	49	53	55	49
88	915	71	64	55	63	71	54	49	52	54	49
88	1315	71	64	54	62	71	53	49	52	54	51
88	1715	70	63	54	62	71	53	48	51	53	51
88	2115	71	63	54	63	72	53	48	51	53	51
89	115	70	63	55	62	72	53	48	51	53	52
89	515	71	62	54	63	72	53	48	51	53	52
89	915	70	62	54	64	72	53	48	51	52	52
89	1354	70	62	54	64	73	53	48	51	52	52
89	1754	69	62	53	65	72	53	48	51	53	53
89	2154	70	61	53	66	73	53	48	51	52	53
90	154	70	62	53	65	73	53	48	51	52	53
90	554	70	62	54	66	74	53	48	51	53	53
90	954	69	62	53	65	74	53	49	51	53	53
90	1354	69	61	53	66	74	53	48	51	52	53
90	1754	69	61	52	66	74	54	49	51	52	53
90	2154	69	61	53	66	74	54	49	51	52	53
91	154	69	61	53	65	74	53	49	51	52	53
91	554	69	60	52	64	74	53	49	51	53	53
91	954	69	59	52	64	74	54	49	51	52	53
91	1328	58	59	52	64	74	54	49	51	52	53
91	1729	68	60	53	64	74	54	49	51	52	53
91	2129	68	59	52	64	74	54	49	51	52	54
92	129	68	59	52	64	74	54	49	52	52	54
92	529	68	58	53	63	74	54	49	51	52	54
92	929	69	58	53	62	74	54	51	51	52	54
92	1329	68	58	53	62	74	54	51	51	53	54
92	1729	67	58	53	61	74	54	51	51	53	54
92	2129	67	57	53	59	74	54	51	51	53	55
93	129	67	57	53	59	74	54	51	51	52	54
93	529	67	56	52	58	74	53	50	51	52	54
93	929	67	55	53	58	74	54	51	51	52	64
93	1329	67	54	52	57	74	55	51	51	52	54
93	1729	65	54	52	56	74	55	51	51	52	55
93	2129	66	54	52	56	74	54	51	51	52	55
94	129	66	53	52	56	74	55	51	52	52	55
94	529	66	53	52	56	74	55	51	52	52	55
94	929	66	53	52	56	74	55	51	52	52	55
94	1407	64	52	52	56	73	55	52	52	52	55
94	1807	63	53	52	56	73	56	51	52	52	55
94	2207	64	52	52	56	73	55	52	52	52	55
95	207	63	53	52	56	73	56	52	52	53	55
95	607	63	52	52	56	73	55	52	52	53	56
95	1007	63	53	52	56	73	56	52	52	53	56
95	1407	62	53	51	56	72	56	52	52	53	55
95	1807	62	53	52	56	72	56	52	53	53	56
95	2207	61	52	51	55	72	56	52	53	53	55
96	207	61	52	52	55	71	56	52	53	53	56
96	607	61	53	52	55	72	56	52	53	53	55
96	930	61	53	51	54	71	56	53	53	53	56
96	936	60	53	51	54	72	56	53	53	53	56
96	1331	60	52	51	54	70	56	53	53	54	52

Table C-8. BAAP Temperature Data (continued), File #2
Piles #1 and 2, Temperatures in degrees C

Day	Time	PROBES 1	2	3	4	5	6	7	8	9	10	Day	DAILY AVG. 1	2	DAILY Stdev 1	2
96	1731	59	53	51	54	70	56	53	54	56	48					
96	2131	59	52	51	54	70	58	53	55	59	47					
97	131	59	52	51	53	69	59	53	56	61	47	97	56.5	54.8	6.5	4.9
97	531	59	52	51	53	69	59	53	56	62	47					
97	931	58	52	51	53	69	61	54	56	63	48					
97	1331	57	52	51	53	68	61	53	56	55	48					
97	1731	57	52	50	55	68	61	53	56	51	49					
97	2131	57	52	49	55	68	61	53	56	48	48					
98	131	57	52	48	56	68	61	53	56	45	47	98	54.9	50.3	7.2	6.6
98	531	56	52	47	55	68	60	53	56	43	46					
98	931	56	52	46	56	68	60	53	55	41	45					
98	1331	55	51	46	55	67	59	53	54	39	43					
98	1510	55	52	45	56	67	59	53	54	39	43					
98	1516	54	52	45	55	67	59	53	54	39	43					
98	1911	54	51	44	54	67	58	52	53	41	45					
98	2311	53	51	43	54	67	56	31	51	43	45					
99	311	53	51	42	53	66	56	49	51	43	46	99	51.7	48.6	7.6	4.1
99	711	52	51	42	52	65	56	49	49	44	46					
99	1111	52	51	41	52	64	56	48	49	44	46					
99	1511	51	51	39	52	63	56	48	48	44	46					
99	1911	51	52	39	51	63	56	48	48	44	46					
99	2311	49	51	38	51	62	55	47	48	44	47					
100	311	48	51	37	51	61	54	47	48	44	47	100	48.8	48.1	7.4	2.9
100	711	48	51	37	50	60	53	47	47	44	47					
100	1111	48	51	37	50	59	53	47	47	45	47					
100	1511	46	51	36	50	59	54	47	48	45	48					
100	1911	46	52	36	49	58	54	46	48	46	48					
100	2311	46	52	36	49	58	53	47	48	46	48					
101	311	46	52	36	48	58	53	47	48	46	48	101	47.8	48.9	7.2	2.2
101	711	46	52	36	48	58	53	47	48	47	48					
101	1111	45	52	36	48	57	53	47	48	48	48					
101	1351	45	52	36	48	58	53	47	48	48	49					
101	1353	45	52	36	48	58	53	47	48	48	48					
101	1753	45	52	36	47	57	53	47	49	48	49					
101	2153	45	52	37	48	58	53	48	49	49	49					
102	153	45	52	37	47	57	53	48	49	49	49	102	47.8	50.3	6.4	1.6
102	553	45	52	37	46	57	52	48	49	51	50					
102	953	45	52	38	46	56	52	48	49	51	50					
102	1353	46	53	39	46	57	53	48	49	51	51					
102	1753	45	53	39	46	57	52	48	51	52	51					
102	2153	46	52	39	46	57	52	48	51	52	52					
103	553	45	52	41	46	56	52	49	51	53	52	103	48.3	52.0	5.5	1.6
103	953	46	52	41	46	57	52	49	52	53	52					
103	1234	46	52	41	46	57	52	50	52	54	52					
103	1239	46	51	41	46	57	53	49	52	53	52					
103	1635	46	51	41	46	58	53	49	53	55	53					
103	2035	46	51	41	47	58	53	49	53	54	53					
104	35	46	50	41	47	58	53	50	53	55	53	104	49.4	53.3	5.6	1.8
104	435	47	50	41	47	58	52	49	53	55	53					
104	835	48	49	42	48	59	53	51	53	55	54					
104	1235	48	49	42	49	59	53	50	54	55	55					
104	1635	50	49	42	50	60	54	51	54	55	55					
104	2035	51	49	43	51	59	53	51	56	55	56					
105	35	52	49	43	51	61	54	51	55	55	56	105	51.8	54.8	5.6	1.9
105	435	52	49	44	52	61	54	51	55	56	56					
105	835	53	49	44	52	61	55	51	56	56	56					
105	1235	53	49	44	52	61	55	52	56	56	56					
105	1635	53	49	44	53	61	55	32	56	57	57					
105	2035	53	49	45	54	61	54	51	57	57	56					
106	35	53	49	45	54	61	54	52	57	57	57	106	52.6	55.7	5.3	2.2
106	435	54	49	45	54	61	55	52	57	57	57					

Table C-8 (cont.)

106	835	54	49	45	55	61	55	52	57	57	57					
106	1235	54	49	45	55	61	55	52	58	58	57					
106	1635	54	49	45	55	61	56	52	58	59	57					
106	2035	53	49	45	55	59	56	54	59	55	53					
107	35	53	49	44	55	59	58	55	60	50	52	107	51.6	53.2	5.2	5.9
107	835	53	48	44	55	59	59	56	60	46	49					
107	1235	53	48	44	55	58	59	56	59	44	48					
107	1635	53	48	43	55	58	58	56	58	43	46					
107	2035	53	48	43	54	58	58	55	57	42	46					
108	35	53	48	43	54	58	57	54	55	41	44	108	50.5	48.8	5.1	6.8
108	435	53	48	43	53	57	57	54	54	39	42					
108	835	53	47	42	53	57	56	53	53	40	41					
108	939	53	47	42	52	57	55	53	52	40	41					
108	941	53	48	42	52	57	56	53	52	39	41					
108	943	53	47	42	52	57	56	53	53	40	41					
109	738	52	46	42	51	56	52	48	48	47	43	109	50.3	46.9	5.3	3.9
109	1138	53	47	42	52	56	52	48	48	48	43					
109	1538	55	47	42	53	57	52	48	47	48	43					
109	1938	54	47	42	53	57	33	48	48	49	43					
109	2338	54	47	42	53	58	46	48	48	51	44					
110	338	54	47	42	53	58	52	48	48	51	44	110	51.0	48.8	5.7	2.9
110	738	54	47	42	53	58		48	48	51	44					
110	1138	54	47	42	54	58		47	48	52	55					
110	1538	54	48	42	54	58		48	48	52	45					
110	1938	54	47	42	54	58		48	49	53	46					
111	338	54	47	41	53	58	54	49	49	53	47	111	50.7	50.9	6.1	2.2
111	738	54	47	41	53	57	54	49	50	53	47					
111	1138	56	46	41	54	57	54	49	51	53	48					
111	1538	56	47	42	53	58	53	49	51	53	48					
111	1938	56	46	41	52	58	53	50	52	53	49					
111	2338	56	46	41	52	58	53	49	52	53	49					
112	338	56	46	41	52	58	53	49	52	53	51	112	50.0	52.3	6.9	2.0
112	738	55	45	41	52	58	53	49	53	54	51					
112	1021	56	44	41	52	58	56	49	53	54	51					
112	1022	55	44	41	52	58	56	49	52	54	51					
112	1422	57	43	39	52	57		49	53	54	52					
112	1822	57	43	39	52	58	54	49	53	54	53					
112	2222	57	43	39	52	58	54	49	54	54	53					
113	222	56	42	39	52	58	54	49	54	53	[illegible]	113	49.2	51.7	7.9	8.4
113	622	56	42	39	52	58	54	49	55	53	53					
113	1022	57	41	39	52	58	55	49	55	53	54					
113	1422	57	41	38	52	57	9	49	56	53	53					
113	1822	57	41	38	52	57	55	49	56	54	55					
113	2222	57	41	38	52	58		49	56	55	56					
114	222	57	41	38	52	58	66	49	57	54	55	114	48.7	54.4	8.2	4.1
114	622	56	39	38	52	57	[illegible]	49	57	54	56					
144	1022	57	40	39	52	57		49	57	55	56					
114	1422	56	39	38	52	57		49	56	57	54					
114	1822	57	39	38	52	57		52	60	53	51					
114	2222	56	39	38	52	57		52	61	49	50					
115	222	57	39	38	52	57	59	52	61	46	48	115	47.5	49.3	8.5	6.6
115	622	57	39	39	52	57	58	52	59	43	46					
115	950	57	39	36	52	57		50	57	42	44					
115	951	56	39	39	52	57		51	58	42	44					
115	958	57	39	39	52	57	57	51	57	42	44					
115	1351	51	38	36	51	58	55	50	56	41	43					
115	1751	51	37	34	49	56	54	49	53	39	41					
115	2151	51	37	33	49	54	53	48	51	38	39					
116	151	52	37	33	48	53	52	48	50	41	39	116	41.9	43.[illegible]	8.1	4.9
116	1836	46	36	28	44	49	48	44	43	38	36					
116	2236	47	35	28	44	48	48	43	42	38	37					
117	236	48	33	28	43	49	48	42	42	40	37	117	40.6	41.8	8.0	3.6
119	1912	52	39	31	42	53		43	38	40	38	119	42.7	40.1	8.5	1.9
119	2312	51	38	28	42	51		43	39	41	39					

Table C-8 (cont.)

120	312	51	38	28	42	50		43	39	42	39	120	41.9	41.9	8.8	1.9
120	712	51	37	28	43	51		43	39	43	40					
120	1112	51	38	28	42	51	42	44	39	43	40					
120	1512	51	37	28	43	51		44	41	44	41					
120	1912	51	37	27	43	51		44	41	45	41					
120	2312	51	37	27	43	51		45	41	44	41					
121	312	51	36	27	43	49		45	41	44	42	121	41.3	44.5	9.0	2.0
121	712	51	36	27	43	49		46	42	45	42					
121	1112	51	36	27	43	49	49	46	43	45	43					
121	1512	51	36	27	43	50	49	46	43	43	43					
121	1912	51	36	27	43	51		47	44	43	45					
121	2312	51	36	27	42	51		46	45	44	46					
122	312	51	36	27	42	51		47	46	45	46	122	40.3	46.6	9.8	1.4
122	712	51	36	27	42	51		47	46	45	47					
122	845	52	35	27	42	52		47	47	45	46					
122	852	51	34	26	42	51		47	47	45	46					
122	1252	48	34	23	41	52		47	48	45	48					
122	1652	48	33	23	40	50		48	49	43	48					
122	2052	48	33	23	39	49		48	49	44	48					
123	52	48	32	22	39	49		48	50	45	48	123	38.2	48.2	10.3	3.0
123	452	49	33	22	39	49		48	51	45	49					
123	852	49	32	22	39	49	53	48	51	45	49					
123	1252	49	32	22	39	49		49	52	48	46					
123	1652	49	31	22	40	49		49	53	46	44					
123	2052	49	31	22	41	49		49	53	42	43					
124	52	49	32	22	41	49		49	53	43	43	124	38.5	47.3	10.4	2.9
124	452	49	31	22	41	49		47	52	45	44					
124	852	49	31	22	41	49		46	51	46	45					
124	919	49	32	22	41	49		46	52	46	45					
124	922	49	31	22	41	49		46	51	45	45					
124	1321	49	31	22	41	49		46	51	46	45					
124	1721	49	31	23	41	49	52	46	51	48	46					
124	2321	49	31	23	42	49		45	51	48	46					
125	321	49	31	23	41	49		45	49	48	46	125	39.3	48.2	10.6	2.0
125	721	50	31	23	42	49	50	46	50	48	46					
125	1121	50	31	23	42	49		46	50	49	47					
125	1521	51	31	23	42	49		46	50	49	46					
125	1921	51	31	24	43	50		46	50	51	47					
125	2321	51	31	24	43	51	52	46	50	51	48					
126	321	51	32	24	43	51	52	46	51	50	48	126	40.7	48.7	10.5	2.7
126	721	52	32	25	43	51	53	46	51	49	48					
126	1056	52	32	25	43	51		46	51	49	49					
126	1457	52	32	26	44	51		47	51	51	49					
126	1857	52	32	26	44	51		47	52	48	45					
126	2257	51	32	26	44	51		48	53	44	43					
127	257	51	32	26	44	51		48	53	52	43	127	40.9	47.6	10.1	3.5
127	657	52	32	27	45	50		47	52	45	44					
127	1057	52	32	26	45	51	52	46	51	45	45					
127	1457	52	32	27	43	51	51	46	31	43	46					
127	1857	52	32	27	42	51	52	46	50	43	46					
127	257	52	31	26	42	50	54	45	49	42	46					
128	257	51	31	27	42	49		45	49	42	46	128	40.5	45.9	9.9	4.1
128	657	52	32	27	43	51		45	49	42	47					
128	1057	52	32	27	42	51	58	45	49	41	47					
128	1457	52	33	27	41	51		46	49	39	48					
128	1857	52	32	27	39	51		45	49	39	48					
128	2257	51	32	27	39	51		44	49	39	48					
129	257	51	32	27	39	51		45	49	36	43	129	39.8	44.7	9.6	6.1
129	657	51	32	27	39	50		45	49	37	42					
129	1057	51	33	27	39	51	52	44	49	37	43					
129	1457	51	32	27	39	50	52	43	48	36	44					
129	1857	51	32	27	38	49	51	42	48	36	45					
129	2257	51	32	26	38	50	64	42	47	37	45					
130	257	50	31	26	38	49		42	47	38	45	130	39.0	44.5	9.9	4.3

Table C-8 (cont.)

130	657	50	31	26	38	49		42	46	38	45					
130	916	50	31	23	39	49	52	42	47	38	46					
130	1317	50	31	25	39	49	51	42	46	38	46					
130	1717	51	31	25	41	50	52	42	47	39	47					
130	2117	50	31	26	41	50	52	42	47	39	47					
131	117	49	31	25	41	49	52	43	47	39	47	131	38.8	46.1	10.1	3.8
131	517	49	30	25	41	49		42	46	39	47					
131	1016	49	29	24	42	49	52	43	47	41	47					
131	1416	50	29	25	42	49	52	43	47	43	47					
131	1816	49	29	24	42	49	52	43	48	45	48					
131	2216	49	29	24	43	49	53	43	47	45	48					
132	216	48	29	24	43	49	53	43	48	46	49	132	38.7	48.3	10.3	2.9
132	616	48	29	24	43	49	53	44	48	46	49					
132	941	48	29	23	43	48	53	44	48	46	48					
132	1341	48	29	24	44	48	53	45	48	48	49					
132	1741	48	29	24	45	49	53	45	48	48	49					
132	2141	48	29	24	45	49	53	46	48	48	49					
133	141	48	29	24	45	48	53	46	48	47	49	133	38.7	48.7	10.4	2.7
133	541	48	28	24	44	49	53	46	48	46	49					
133	941	48	28	24	45	49	54	46	48	47	49					
133	1341	48	28	24	44	48	53	46	48	46	49					
133	1741	48	29	24	45	49	54	46	48	47	50					
133	2141	48	28	26	45	49	54	47	48	46	51					
134	141	48	28	24	45	49	55	46	49	47	51	134	38.8	49.8	10.9	3.1
134	541	48	28	23	44	49	55	47	48	46	51					
134	941	49	28	26	45	49	55	47	49	46	50					
134	1341	49	28	23	45	49	55	48	49	47	51					
134	1741	49	28	23	45	49	56	47	49	48	51					
134	2141	49	28	23	45	49	56	48	49	48	51					
135	141	49	28	24	45	49	55	48	49	48	51	135	38.9	50.6	11.2	2.9
135	541	49	27	23	45	49	56	48	50	47	51					
135	941	49	28	23	45	49	56	47	49	47	51					
135	1341	50	28	24	46	49	56	48	51	51	49					
135	1741	49	27	23	46	49	55	48	51	50	49					
135	2141	49	26	24	46	49	56	48	51	51	51					
136	141	49	28	25	46	49	56	48	51	51	51	136	39.3	50.4	10.6	3.7
136	541	49	27	25	46	49	56	47	50	51	51					
136	920	49	28	25	46	50	56	47	49	51	51					
136	1320	49	28	25	46	49	56	48	49	52	51					
136	1827	49	28	25	46	49	56	48	50	45	50					
136	2227	49	28	26	43	49	56	48	51	39	48					
137	227	49	28	26	43	49	56	48	51	39	48	137	38.8	48.1	10.2	4.7
137	627	49	28	26	43	49	55	47	51	41	48					
137	1027	49	28	25	42	49	55	46	49	41	49					
137	1427	49	28	26	43	49	55	46	49	42	49					
137	1827	49	28	25	42	49	55	46	48	41	49					
137	2227	49	28	25	42	49	55	45	48	41	49					
138	227	49	28	26	42	49	55	46	48	42	49	138	38.4	47.3	10.2	4.2
138	627	49	28	25	42	49		45	48	42	48					
138	1027	49	28	25	42	49	55	45	48	42	48					
138	1427	49	28	24	42	49	55	46	48	42	49					
138	1530	49	28	24	41	49	55	46	48	39	49					
138	1930	48	28	24	41	48	55	46	48	41	49					
138	2330	49	28	25	41	49		46	48	42	49					
139	330	48	28	24	41	48	55	45	48	42	49	139	37.6	48.1	10.2	4.4
139	730	48	28	24	41	48	55	45	48	43	49					
139	1130	48	27	24	41	48	55	46	48	42	50					
139	1530	48	27	24	41	48	55	45	48	43	50					
139	1930	48	27	24	41	48	56	45	48	43	50					
139	2330	47	26	23	41	48	56	44	48	43	50					
140	330	47	26	24	40	47	56	44	49	43	51	140	36.3	46.8	10.3	3.7
140	730	46	25	23	40	48		43	49	44	47					
140	1000	46	25	23	41	48		43	49	44	48					
140	1400	46	25	23	40	47		42	48	45	49					

Table C-8 (cont.)

140	1800	46	25	23	39	47		42	47	46	49					
140	2200	45	24	23	40	47	56	42	47	46	49					
141	200	44	25	23	40	47		42	47	46	49	141	35.9	47.0	9.8	3.2
141	600	45	25	24	39	46		43	47	46	49					
141	1000	45	25	23	40	47		42	47	46	49					
141	1400	45	25	23	40	46		43	47	47	49					
141	1800	44	25	23	40	46	55	43	47	48	49					
141	2200	45	25	24	41	46	55	43	47	48	49					
142	200	45	25	24	41	46	55	44	47	48	49	142	35.9	48.2	9.3	2.8
142	600	44	25	24	40	46	55	44	47	47	50					
142	1000	44	25	24	39	46		44	48	48	49					
142	1400	44	25	24	40	45		45	48	48	49					
142	1800	44	25	25	40	46		45	48	50	50					
142	2200	44	26	25	41	46		45	48	51	51					
143	200	43	26	26	41	46		46	49	50	48	143	36.3	49.1	8.5	2.9
143	600	43	26	26	41	46		46	51	47	48					
143	1000	43	26	26	40	46		46	49	49	49					
143	1318	43	26	26	41	46	58	46	49	49	49					
143	1718	43	27	27	41	46	56	46	49	49	50					
143	2118	42	26	26	39	46	55	46	48	48	50					
144	118	42	27	26	39	46	55	45	48	48	49	144	35.2	47.7	8.2	4.4
144	518	42	26	26	39	46	55	45	47	47	49					
144	918	42	26	26	39	46	55	44	46	45	49					
144	1318	41	26	25	[illegible]	45	56	44	47	43	49					
144	1718	41	26	25	37	45	55	44	46	41	48					
144	2118	41	26	23	33	45	55	43	45	39	48					
145	118	41	26	23	34	45	55	43	45	39	48	145	32.9	46.5	8.4	5.1
145	518	41	25	23	33	44	56	43	46	39	48					
145	918	39	25	22	34	45	55	43	46	39	48					
145	1318	40	25	22	33	44	55	43	46	40	47					
145	1519	40	25	22	33	44	55	43	46	41	48					
145	1520	39	24	22	33	45	56	43	46	41	48					
145	1920	39	24	22	33	44	55	43	46	41	48					
145	2320	39	24	22	33	43	55	42	46	42	48					
146	320	39	24	22	33	43	55	43	46	42	48	146	31.8	46.7	8.2	4.9
146	720	39	24	22	33	43	55	42	46	42	48					
146	1120	38	23	21	33	43	55	42	46	42	48					
146	1520	38	26	22	33	44	55	42	46	44	48					
146	1920	38	23	21	33	42	56	42	46	42	48					
146	2320	38	23	22	32	42	55	42	47	40	48					
147	320	37	23	21	31	42	56	42	47	38	48	147	30.5	46.4	7.6	6.1
147	1102	37	23	22	31	41	56	42	46	39	49					
147	1104	37	23	22	31	41	56	42	47	39	49					
147	1504	37	23	22	30	41	57	42	47	38	49					
147	1904	36	23	21	29	41	56	42	47	38	49					
147	2304	36	23	21	29	40	56	41	46	39	49					
148	304	36	23	21	29	39	56	42	47	39	48	148	29.2	46.1	6.8	6.0
147	704	36	23	21	29	39	59	41	47	39	49					
148	1104	35	23	21	29	39		41	46	39	49					
148	1504	36	23	21	29	38	56	42	47	41	49					
148	1904	34	22	20	29	38		41	47	41	49					
148	2304	34	23	20	28	37	61	41	46	40	49					
149	304	34	23	20	29	37		41	46	38	48	149	27.9	44.9	6.5	5.3
149	704	34	23	20	28	37		41	46	39	49					
149	1104	34	23	19	23	37	56	41	46	39	49					
49	1504	34	23	19	28	36	55	41	46	38	49					
9	1904	33	22	19	28	36	55	41	46	39	49					
	2304	33	23	19	28	36		40	46	39	49					
	304	33	22	20	28	34		39	46	39	49	150	27.2	43.3	6.6	4.0
	704	33	23	20	28	36		39	46	40	49					
	904	33	23	20	14	36		40	45	40	48					
	906	33	23	20	28	34		39	45	40	49					

Table C-9. BAAP Temperature Data, Piles 3 and 4
probes 1-5 = pile 3; probes 6-10 = pile 4

Day	Time	PROBES (temp in C) 1	2	3	4	5	6	7	8	9	10	Daily Average Day	3	4
0	1822	29	37	29	32	32	19	19	18	18	19	0	32	19
1	22	29	41	31	35	34	19	21	19	19	19	1	37	22
1	622	31	43	33	37	37	21	23	20	21	21	2	45	28
1	1222	33	46	36	39	38	22	25	21	23	22	3	50	34
1	1822	34	48	38	41	39	22	27	23	26	23	4	57	39
2	23	36	49	42	43	41	22	29	24	27	24	5	61	44
2	623	37	52	43	43	42	23	31	25	29	25	6	64	48
2	1223	39	52	45	45	43	23	33	27	31	25	7	60	52
2	1542	39	53	46	46	44	24	34	28	31	27	8	60	54
2	1547	40	53	45	46	44	24	34	27	31	27	9	64	56
2	2146	41	56	47	47	46	24	36	29	33	28	10	67	58
3	346	42	57	48	49	46	25	38	30	34	29	11	69	56
3	946	43	58	50	50	47	26	41	32	35	31	12	70	55
3	1546	44	60	52	51	48	27	42	33	36	33	13	66	54
3	2146	46	62	53	52	49	28	44	34	37	35	16	60	54
4	346	46	64	56	53	51	29	46	36	39	37	15	60	57
4	946	48	67	58	55	52	30	47	37	39	39	16	64	59
4	1546	49	69	61	57	54	32	49	37	41	41	17	65	60
4	2146	51	70	62	58	56	33	51	38	41	44	18	60	60
5	347	52	70	63	59	57	34	52	39	42	47	19	51	59
5	947	53	69	63	60	58	36	53	40	43	48	20	47	60
5	1219	53	70	64	60	58	36	53	41	42	49	21	53	60
5	1224	53	70	64	61	58	36	53	41	42	49	22	60	61
5	1824	54	71	65	61	58	37	54	41	43	51	23	48	62
6	24	56	73	68	61	58	38	56	42	44	52	24	42	60
6	624	59	73	68	62	58	39	57	41	45	53	25	47	61
6	1224	63	72	64	62	59	41	59	42	46	54	26	56	56
6	1824	66	70	60	60	59	42	62	42	46	56	27	57	53
7	24	66	69	58	58	58	43	63	42	47	56	28	34	55
7	624	66	69	57	56	56	44	64	43	48	57	29	29	61
7	1052	64	69	56	53	55	44	64	44	48	57	30	27	56
7	1058	64	69	56	53	55	44	64	43	48	58	31	30	51
7	1657	64	71	56	51	53	46	66	44	49	58	32	36	53
7	2257	63	71	58	49	52	47	66	45	49	59	33	43	57
8	458	63	72	61	47	51	48	67	45	49	59	34	53	58
8	1058	63	72	64	46	51	49	67	46	49	61	35	61	57
8	1658	62	72	67	46	52	49	68	46	49	61	36	65	56
8	2258	63	73	69	46	53	51	68	46	50	61	37	59	56
9	458	64	73	70	48	55	52	69	47	51	62	38	55	54
9	1058	66	74	72	49	56	52	69	47	51	62	39	49	45
9	1325	66	73	73	52	57	52	69	48	51	62	40	45	44
9	1328	66	74	73	52	58	52	70	47	51	62	41	47	49
9	1928	67	74	73	54	59	53	71	47	52	62	42	50	53
10	128	69	74	72	56	61	54	71	48	52	61	43	51	55
10	728	70	74	72	57	62	55	72	49	53	61	44	55	55
10	1328	71	74	72	58	63	56	72	51	53	60	45	48	53
10	1928	72	74	72	60	64	56	72	52	54	61	46	37	46
11	128	72	73	72	61	64	57	73	42	51	62	47	29	41
11	728	73	73	73	62	64	57	73	37	44	63	48	26	45
11	1328	74	72	73	63	66	58	73	36	43	65	51	42	16
11	1928	73	72	73	64	66	59	73	36	43	66	54	31	41
12	128	74	72	73	66	66	60	76	34	42	66	62	45	58
12	728	74	72	73	66	66	61	74	34	42	66	63	55	25
12	1246	73	72	71	67	66	61	74	33	42	66	68	61	54
12	1247	74	72	70	67	67	61	73	33	42	66	72	64	56
12	1847	73	68	67	67	66	62	73	33	42	63	75	32	50
13	47	73	67	66	67	66	62	73	32	41	62	77	24	32
13	647	72	65	66	67	66	63	74	31	41	61	79	13	34
13	1267	71	63	61	66	63	63	74	29	40	63	82	8	36
13	1847	69	61	58	64	63	63	73	31	40	65	84	7	36
14	47	68	61	57	63	61	63	73	30	39	66			
14	647	66	59	55	61	59	63	72	29	37	67			
14	1020	66	58	54	60	59	63	72	29	37	68			

14	1021	66	58	54	60	58	63	72	29	37	68
14	1621	64	59	54	58	58	63	73	32	38	70
14	2221	63	59	54	57	57	64	73	33	38	71
15	421	63	61	56	55	56	64	73	33	38	72
15	1021	63	62	58	55	56	64	74	34	37	72
15	1621	63	64	61	55	56	64	75	37	39	72
15	2221	63	64	63	56	58	64	76	38	39	72
16	421	64	64	65	58	59	65	75	37	38	72
16	1021	65	65	66	61	61	64	76	39	39	72
16	1621	65	67	66	63	63	65	76	42	42	73
16	2221	66	67	66	63	64	66	76	42	42	72
17	421	66	64	65	64	66	66	76	42	41	72
17	1021	66	62	64	64	67	65	76	42	40	72
17	1621	66	64	62	64	67	66	76	45	43	73
17	2221	67	63	59	63	68	66	76	46	42	73
18	421	66	59	56	62	69	66	74	46	42	73
18	1021	66	58	52	60	67	66	74	47	42	73
18	621	64	57	47	58	67	66	76	49	42	72
18	2221	64	59	42	54	66	66	75	49	42	68
19	421	63	53	39	49	63	65	75	47	41	67
19	844	63	50	37	48	62	66	74	46	40	67
19	846	63	50	37	48	62	66	74	46	40	67
19	1445	62	44	34	45	59	66	74	45	41	67
19	2045	61	41	33	43	58	66	73	45	42	68
20	245	59	40	34	43	55	66	73	46	42	69
20	845	58	41	36	43	53	66	72	47	41	70
20	1645	57	47	37	44	52	66	72	50	42	72
20	2045	54	51	38	47	51	66	72	52	42	71
21	245	55	54	42	49	51	66	71	51	42	72
21	[illegible]	54	62	43	48	48	66	71	51	41	72
21	1046	55	64	46	49	48	66	71	52	42	72
21	1648	54	69	50	52	49	66	71	52	42	72
21	2248	55	72	51	53	48	66	71	52	42	72
22	448	56	75	57	57	51	66	71	52	41	73
22	1048	57	65	62	63	61	66	70	52	42	73
22	1648	61	61	61	59	65	66	71	55	44	74
22	2248	62	51	57	55	66	66	71	55	44	73
23	448	62	44	51	49	64	66	71	55	46	73
23	1024	61	38	43	45	62	66	71	55	46	72
23	1626	58	36	36	39	59	66	72	54	48	70
23	2226	56	33	29	35	56	66	71	51	48	68
24	426	53	34	29	31	54	66	71	48	48	67
24	1026	51	41	35	29	51	66	71	45	47	67
24	1626	51	49	39	29	48	66	71	45	48	68
24	2226	49	55	44	29	46	67	71	45	47	69
25	426	49	62	49	31	46	66	70	46	47	69
25	1026	49	64	53	33	5	67	70	51	47	70
25	1626	50	61	66	34	45	67	70	55	48	69
25	2226	50	32	67	37	47	67	71	52	48	65
26	426	51	58	67	40	48	67	70	48	47	61
26	1026	52	59	69	43	52	67	69	43	47	58
26	1451	52	63	69	44	53	67	68	40	47	55
26	1452	52	63	69	45	53	67	68	41	48	56
26	2052	53	69	68	51	57	67	67	36	47	53
27	252	54	74	71	54	59	68	67	33	44	53
27	852	55	70	63	59	64	67	67	31	46	55
27	1452	58	61	32	59	63	67	67	32	46	52
27	2052	59	56	19	49	55	67	66	33	46	57
28	252	58	44	14	39	48	67	66	33	46	58
28	852	55	36	9	31	42	37	66	33	45	61
28	926	56	36	9	31	41	67	66	33	45	61
28	1528	54	15	16	29	39	67	67	36	47	64
28	2128	51	16	16	27	39	67	67	38	47	67
29	328	48	19	17	25	38	67	68	42	48	70
29	928	46	21	18	25	37	67	68	46	49	72
29	1528	45	21	19	24	36	67	68	50	51	73
29	2128	43	24	19	22	34	67	68	52	52	69

30	328	42	28	21	23	33	69	68	47	52	61
30	825	8	33	21	26	33	69	67	42	52	56
30	1402	40	25	22	26	32	69	66	36	52	52
30	1426	39	23	22	24	32	69	65	36	51	51
30	2026	38	23	19	23	32	69	64	32	51	48
31	226	37	27	20	24	31	69	64	27	50	47
31	826	36	31	22	24	31	69	63	24	49	48
31	1426	36	36	23	26	31	69	63	23	50	49
31	2026	35	41	25	27	31	69	63	23	49	51
32	226	34	46	27	27	31	69	63	22	49	53
32	826	34	51	29	28	32	69	63	22	48	57
32	1426	34	56	33	30	32	69	63	26	51	62
32	2026	35	60	36	31	33	69	63	29	51	64
33	226	35	62	40	33	33	69	63	31	51	67
33	826	36	64	44	34	34	69	63	34	51	67
33	1336	36	70	48	36	36	69	63	37	51	69
33	1937	36	56	52	39	38	70	64	41	52	66
34	137	38	67	56	41	41	71	66	41	52	63
34	737	39	66	59	44	42	71	66	38	52	62
34	1337	41	72	67	47	45	71	66	37	52	62
34	1551	41	72	67	48	46	71	65	37	52	62
34	1937	42	73	66	49	47	71	64	37	52	62
35	137	44	73	69	52	49	72	63	36	51	63
35	737	46	76	71	53	51	71	62	34	49	66
35	1155	47	76	72	54	53	71	62	34	49	66
35	1757	49	77	74	56	56	72	62	36	49	65
35	2357	51	77	74	58	59	72	62	36	49	64
36	557	52	78	76	59	61	71	62	35	49	62
36	738	53	78	76	59	63	71	62	34	50	61
36	1157	53	76	76	61	64	72	62	34	50	61
36	2357	58	62	61	66	64	72	62	34	52	59
37	557	60	56	57	66	64	72	62	34	52	59
37	1105	61	52	52	66	64	71	62	35	52	60
37	1706	62	49	48	66	64	71	62	37	53	61
37	2306	63	48	42	67	64	72	62	37	53	60
38	506	64	51	38	67	63	71	63	36	52	58
38	1106	64	52	34	66	62	71	63	33	51	55
38	1706	64	50	31	65	61	71	61	31	49	52
38	2306	64	51	27	63	56	71	59	28	49	48
39	506	63	58	23	62	55	71	56	24	47	43
39	1106	63	52	19	61	53	72	55	21	46	38
39	1706	63	55	17	59	49	70	53	17	45	36
39	2306	62	53	17	58	47	70	52	16	43	34
40	506	62	47	17	58	46	69	52	14	43	36
40	1015	62	42	18	57	46	67	52	13	42	38
40	1616	61	50	25	51	40	67	52	18	48	43
40	2216	59	53	28	47	39	66	53	21	48	44
41	416	58	57	30	44	38	63	54	22	48	46
41	1016	57	61	31	45	38	64	57	23	48	47
41	1616	57	69	33	45	38	63	61	26	49	49
41	2216	56	69	34	45	37	62	63	27	49	51
42	416	56	70	36	45	37	62	64	29	49	52
42	1016	56	71	38	46	38	62	66	31	51	53
42	1515	55	71	39	47	39	62	66	33	52	54
42	2116	56	71	42	49	39	61	67	34	52	54
43	316	56	69	43	50	41	61	67	36	53	56
43	916	56	62	45	52	42	62	67	37	54	55
43	1516	56	58	45	54	43	62	66	37	55	54
43	2116	57	53	44	56	44	61	66	37	55	53
44	316	57	63	44	57	44	62	64	38	56	53
44	916	57	68	46	50	45	62	64	39	56	54
44	1516	58	70	48	59	46	62	65	39	56	55
44	2120	59	56	34	65	58	63	66	32	55	54
45	320	62	46	31	62	61	63	64	29	58	55
45	920	63	41	27	56	59	64	63	29	58	54
45	1520	63	35	22	53	57	64	62	27	56	51
45	2120	63	29	19	48	54	64	61	26	53	49

Table C-9 (cont.)

46	320	43	28	16	43	52	46	40	26	49	46
46	920	42	23	13	41	48	45	40	22	46	42
46	1520	41	22	13	[illegible]	46	46	59	21	41	41
46	2120	39	18	1[illegible]	31	43	43	58	19	37	41
47	320	38	16	10	[illegible]	41	43	56	19	33	43
47	920	37	16	11	27	38	42	56	18	31	41
47	1416	36	14	9	[illegible]	36	41	56	18	29	41
47	2017	36	14	9	25	37	41	56	19	29	40
48	217	31	22	17	22	33	41	53	36	33	43
48	817	49	24	18	23	33	41	56	28	36	46
48	1417	13	13	13	13	13	60	58	29	36	47

Recorder broken at this point, subsequent temperatures taken with landfill thermocouple probe and hand-held digital thermometer

Day	PILE 3									Day	Average (C)
51	37	40	35	42	36	36	30	32	47	51	62
54	5	20	51	22	51	59	11	28	35	54	31
62	27	36	59	31	57	62	60	45	49	62	65
63	43	62	66	68	64	39	53	66		63	55
66	60	60	59	66	66	64	60	59	57	66	61
72	51	47	37	51	46	42	41	63	38	72	46
75	36	35	29	31	32	33	28	29	31	75	32
77	21	26	28	27	28	26	22	25	22	77	26
79	14	14	13	16	16	14	18	10	9	79	13
82	8	9	9	9	10	8	7	6	5	82	8
86	6	8	7	9	9	7	3	5	6	86	7

Day	PILE 4									Day	Average (C)
51	13	15	17	13	16	10	12	12	13	51	14
54	39	41	37	45	45	50	40	37	36	54	41
62	58	57	58	63	67	63	52	48	58	62	58
63	19	22	26	29	28	30	32	28	21	63	25
66	45	43	42	46	56	52	57	57	59	66	54
72	47	46	46	60	60	62	61	61	68	72	56
75	46	47	46	45	52	52	49	54	57	75	50
77	43	46	34	37	59	58	36	54	56	77	52
79	26	26	25	25	36	36	46	44	46	79	34
82	22	26	22	36	39	39	47	49	49	82	36
86	21	28	17	39	43	41	47	49	49	86	36

Table C-10. Percent Moisture of Compost from BAAP Composting Field Demonstration.

Phase 1			
Compost Pile #1		Compost Pile #2	
Week	% Moisture	Week	% Moisture
0	61	0	59
0	61	0	62
0	61	0	63
0-ave	61	0-ave	61
3	47	3	52
3	48	3	48
3	49	3	50
3-ave	48	3-ave	50
6	pre-remix	6	pre-remix
6	60	6	60
6	66	6	17
6	58	6	63
6-ave	61	6-ave	67
6	post-remix	6	post-remix
6	65	6	63
6	66	6	65
6	65	6	66
6-ave	63	6-ave	65
8	66	8	68
8	66	8	66
8	66	8	62
8-ave	66	8-ave	63
10	60	10	64
10	62	10	64
10	63	10	64
10-ave	62	10-ave	64
14	47	14	58
14	48	14	57
14	49	14	55
14-ave	48	14-ave	57
22	25	22	51
22	28	22	nd
22	28	22	50
22-ave	27	22-ave	51

Phase 2			
Compost Pile #3		Compost Pile #4	
Week	% Moisture	Week	% Moisture
0	58	0	59
0	56	0	59
0	53	0	58
0-ave	56	0-ave	59
4	27	4	38
4	25	4	39
4	25	4	35
4-ave	26	4-ave	37
7	49	7	46
7	48	7	43
7	49	7	45
7-ave	49	7-ave	45
14	30	14	34
14	30	14	35
14	27	14	34
14-ave	29	14-ave	34